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Yale

ELEVENTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE.

1875-76.

11-20

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The undersigned, in behalf of the State Board of Visitors of the Sheffield Scientific School, would respectfully report that in discharge of their duties they have held the usual meetings during the year; one for the purpose of selecting for the several scholarships open to students, under the laws of the State, those applicants found to be properly qualified; and another at which examination was made of the progress of the School, and especially of its development in connection with the Peabody Museum, the building for which is now completed and prepared to receive much material belonging to the collections of the Scientific School, and to afford commodious rooms and special apartments for instruction in several of its departments.

The report of the Governing Board and Faculty of the Institution, which is herewith submitted, will furnish in detail all needful information respecting the present condition and future promise of the School, and this Board take pleasure in commending the course of instruction now pursued there, and the wisdom, intelligent zeal and personal energy of its corps of instructors, by which the School has been brought to its present leading position among the scientific schools of the country.

The free scholarships which have been so wisely provided by the State, are now largely taken up and with most gratifying results.

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1876.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

With the exception of the addition of two new professors to its corps of permanent instructors, the past year has been one of the least eventful in the history of the School; and in presenting their eleventh annual report the Governing Board can do little but repeat the general statements that have already been frequently made in regard to its condition and prospects. As the change in the time of the meeting of the legislature, in consequence of the amendment of the Constitution to that effect, renders necessary the preparation of an additional report during the current year, it has been deemed advisable to make the present one as brief as possible.

The Peabody Museum.

The Peabody Museum, referred to in the last report, is rapidly advancing towards completion. When finished, the instruction in Mineralogy, Zoology, and Comparative Anatomy, will be given in that building; and laboratories have already been or are being fitted up for that purpose. At the beginning of the spring term, the instruction in Determinative Mineralogy was transferred from Sheffield Hall to the Museum, and that in the other branches mentioned will follow in the course of the next Academic year. A full report of these changes will be found in the next annual report.

Gifts to the Institution.

A gift of one thousand dollars was received for the purpose of painting Sheffield Hall, and in accordance with the terms of the donation the work was completed during the summer vacation of 1875.

Additions to the Corps of Professors.

At the Commencement of 1875, two new professorships were created; one of Chemistry, the other of Comparative Anatomy.

To the former Mr. W. G. Mixter was called. Mr. Mixter was graduated from this school in 1867, remained here several years after graduation, pursuing his studies in Chemistry, and was also employed, first as an assistant and subsequently as an instructor in the department of Chemistry. In 1872 he went to Germany, and after spending two years in study in that country, returned to America in 1874, and during the year preceding his appointment gave instruction in Chemistry in the Scientific School. To the chair of Comparative Anatomy Mr. S. I. Smith was elected. He was also graduated from this school in 1867, and since that time has been constantly connected with it as an assistant and subsequently as an instructor.

Instruction in the Use of the Plane Table.

The arrangement by which members of the school could receive instruction in the use of the Plane Table, and in field work, under the operation of the United States Coast Survey, was continued during the past year, though with some modifications. Four topographical parties were constituted and stationed in different sections, one in the Saltonstall Region, one on the New Haven Plain, one east of West Rock Ridge, and one in the Woodbridge Valley. By the plan which had been recommended by Mr. Bache, the Assistant in charge of the region about New Haven, and approved by the Chief of the Coast Survey, each party was made up of a number of paid workers and of such volunteers as might wish to receive instruction. Of the twelve regular employés making up the four parties, the following eight were either students or recent graduates of the Scientific School: H. Andrews, J. P. Bogart, C. V. Pendleton, L. H. Gager, J. G. Bramley, C. McK. Craig, E. B. Chandler, H. D. Bristol. Of the volunteers there were five, all of whom were students in the Scientific School. Their names were as follows: D. R. Alden, W. C. Butler, J. A. Doolittle, E. Gillette, and G. L. Wilson. All of these attached themselves to the party operating in the Woodbridge Valley, that region being the one most easy of access.

Contributions to the Study of the New Haven Region.

To the courtesy of Mr. Bache the Governing Board are under obligations for a report of the operations of the parties, and for the additional contributions to the study of the New Haven Region which follow.

"It was intended," says Mr. Bache, in his communication to the Governing Board, "to put the parties into the field by April 1st, but the appropriation for the work was not available until July 1st, when the work was begun, ending with the close of November.

"The zone of operations was within a belt of land about four miles in width, stretching from Saltonstall Ridge to Woodbridge Ridge. Just before, and at times during the season, Mr. Andrews, my chief aid, executed the supplementary triangulation, under my general direction. As few of the determinations are represented on the ground by permanent objects, such only are given, with some distances. A few bench-marks in some well-known localities are also given.

"The work of the season consisted of thirty-one triangulation points, one hundred and twenty-four bench-marks for contouring, and twenty-nine square miles of topography. This makes, with what was executed when the survey was merely begun, and then discontinued, four seasons ago, thirty-five square miles towards the topography of the New Haven Region, which includes about one hundred and twenty square miles."

Geographical Positions in the New Haven Region †

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
East Haven Green Flag-pole,	41	16	29.970	72	52	04.261
Montowese Spire,	41	20	53.414	72	51	45.920
Centreville Spire,	41	22	59.516	72	54	11.635
North Haven Spire,	41	23	10.904	72	51	42.768
City Hall Tower,	41	18	24.475	72	55	30.022

Distances between Triangulation Points within the New Haven Region.

	Meters.
Rabbit Rock* to Montowese Spire,	1073.6
" Centreville Spire,	6226.6
" North Haven Spire,	5027.4
" East Haven Green Flag-pole,	7488.3
Mt. Carmel* to Montowese Spire,	9430.8
" Centreville Spire,	5358.2
West Rock North* to Montowese Spire,	9171.9
" Centreville Spire,	4957.9
" North Haven Spire,	8426.7
East Rock* to City Hall Tower,	2768.1
West Rock* to City Hall Tower,	4138.6

† The latest Coast Survey *data* for latitude and longitude have been used in the computation of these points.

* The geographical positions of the points thus marked, computed according to the Coast Survey's old *data*, were published in the Scientific School's Report of 1871–72, from the triangulation of Mr. Edward Goodfellow, Assistant U. S. *Coast Survey.*

A few Bench Marks in well known Localities.

	Feet.
Southwest corner of second step at the south front entrance to East Haven Church,	21.792
Cross cut on stone door-step of Foxon School-house,	41.013
Top of stone post at the southwest corner of Main and Franklin streets, Westville,	53.458
Top of iron bolt marking the position of "West Rock North," a triangulation point about one and a half miles north of Wintergreen Lake,	559.417

"The plane," continues Mr. Bache, "to which these and all previous elevations are referred, and all future ones will continue to be, is the plane of Mean High Water at Chapel Street Bridge, as determined by the Coast Survey in 1871, during a whole lunation. The height of the lower plane (cut with a saw), on the top of a pile on the north side of the east end of Chapel Street Bridge, is 2.630 feet above the plane of Mean High Water, as there determined. The mean rise and fall of tide there was published in the School's Report of 1871–72, as 6.25 feet, but should have been, according to the tidal record, 6.23 feet. Even this, however, is a small amount in excess of the truth, as has been since ascertained from tidal observations in other parts of the Harbor. The slight excess is owing to local causes at Chapel Street Bridge."

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. F. Clark, Assistant.

The principal additions to the Zoölogical collections during the past year have been made in connection with the explorations of our coast by the United States Commission of Fish and Fisheries, which was located during the summer at Wood's Hole, Mass., on the shore of Vineyard Sound. At this place an excellent zoölogical laboratory—which we hope may be a permanent one—was established, and provided with aquaria and other unusual facilities for the study of marine animals; while the U. S. tug "Bluelight," Commander L. C. Beardslee, was employed, as during several previous summers, for exploring and dredging in the waters of Buzzard's Bay, Vineyard Sound, Nantucket Shoals, etc. The investigation of the marine invertebrates was under the immediate charge of the curator and Professor S. I. Smith, assisted by Mr. S. F. Clark, Mr. C. H. Merriam, Mr. J. K. Thacher, Mr. O. Harger, Mr. Sanderson Smith, Mr. W. H. Dall, and several others. The very extensive collection thus made is now in our possession for study, *and for future distribution* of the duplicates.

A part of the marine invertebrates collected by Dr. J. H. Kidder, U. S. N. at Kerguelen Island, and at New Zealand by Dr. E. Kershner, U. S. N., during the Transit of Venus Expedition, were sent here for study, and a report on the Crustacea was prepared by Professor Smith, and others on the Annelids, Echinoderms, and Polyps by the curator. From this collection our museum received a valuable set of duplicates.

Professor S. I. Smith and Mr. S. F. Clark spent a short time at the Smithsonian Institution during the winter vacation. Professor Smith selected a small but valuable series of duplicate Crustacea for our museum, and Mr. Clark brought back the extensive collection of Hydroids made on the coast of Alaska by Mr. W. H. Dall, and has subsequently determined and described the species. A large series of duplicates from this collection will be added to our Museum. Mr. Clark has also described the Hydroids of the California coast in a paper presented to the Connecticut Academy of Science.

The collections of invertebrates from the Gulf of St. Lawrence, collected by Mr. J. F. Whiteaves and sent to Professor Smith and the curator for examination, have been mostly determined and returned, while a series of duplicates from these have also been added to our museum.

From Mr. Henry Hemphill we have received a collection of Crustacea, Echinoderms, Hydroids, Bryozoa, Sponges, etc., from California.

From Dr. Edward Palmer we have also received an important collection of marine invertebrates from southern California.

Professor B. Silliman has presented a collection of fishes, insects, and crustacea, from the Mammoth Cave.

From Professor A. Hyatt, of the Boston Society of Natural History, we have received a valuable set of sponges, identified by him, in connection with his monographic work on the group.

Mr. T. Tomita, Vice-Consul of Japan, presented a specimen of the giant crab of Japan.

Mr. A. G. Wetherby, of Cincinnati, sent a collection of land and fresh water shells.

Several other collections of less importance, which will be enumerated on another occasion, have been received from various sources.

Professor J. D. Dana has presented a valuable lot of Zoölogical *books, including a complete series of the Proceedings of the Zoölogical Society of London.*

Additions to the Geological Collections.

O. C. Marsh, Curator; O. Harger, Assistant.

Very important additions to the geological department of the Museum have been made during the year, principally by parties of collectors employed by the curator during the last season in various parts of the West. Several thousand specimens of vertebrate fossils have been thus obtained from the Cretaceous and Tertiary deposits of the Western territories. Many of these are new to science, and some of them of the greatest interest. Among them should be specially mentioned several very perfect specimens of the large and remarkable toothed birds of the genus *Hesperornis*. So complete are these specimens now in the Museum that a study of them promises to determine the characteristics of this group of birds more perfectly than any other fossil birds have been determined, with the possible exception of one or two forms which have very lately become extinct. The Museum has also received much material toward the further elucidation of the characters of the *Dinocerata*, the *Brontotheridæ*, the *Tillodontia* and other hitherto little known groups.

An interesting collection of fossils, mostly vertebrate, has also been received from Mr. G. B. Grinnell and Mr. E. S. Dana who were connected during the last summer with Col. W. M. Ludlow in his trip through the Yellowstone region. These fossils afford evidence of a hitherto unknown Miocene lake basin in the vicinity of Camp Baker, Montana.

The Museum has also received through Prof. Dana several bones of the Reindeer from the Quinnipiac clay pits of North Haven. These bones were carefully collected and presented to the Museum by Capt. S. P. Crafts, the owner of the clay-pits, and are of great interest, as proving the existence of the Reindeer in Southern New England near the close of the glacial period.

Large additions have also been made to the Osteological collection during the year, and many skulls and skeletons, principally of foreign mammals and birds, have been added to the collection. Hon. J. W. Garrett, President of the Baltimore and Ohio Railroad has lately presented to this department the skeleton of the celebrated mare "Esnea," imported from Arabia. A large number of skeletons, mostly of birds, have been received from Mr. G. B. Grinnell during the year. Another interesting acquisition is a series of fifty casts of human and other mammalian brains obtained by the *curator from the Royal College* of Surgeons, London.

Public Lectures.

The tenth annual course of lectures to mechanics and others was given during the past year in the lecture-room in North Sheffield Hall. The lectures and their subjects are indicated in the annexed programme.

I.	Mon.,	Feb. 7.	Waves,	C. S. Lyman.
II.	Thurs.,	" 10.	Yosemite.	Wm. H. Brewer.
III.	Mon.,	" 14.	The English Language in America,	T. R. Lounsbury.
IV.	Thurs.,	" 17.	Coffee,	D. C. Eaton.
V.	Mon.,	" 21.	Perspective,	F. R. Honey.
VI.	Thurs.,	" 24.	Turbine Water Wheels,	E. C. Geyelin.
VII.	Mon.,	" 28.	Our Trap Rocks,	G. W. Hawes.
VIII.	Thurs.,	March 2.	Sound,	J. Kennedy.
IX.	Mon.,	" 6.	Watt and the Steam Engine,	J. E. Clark.
X.	Thurs.,	" 9.	The Cost of Labor,	F. A. Walker.
XI.	Mon.,	" 13.	Watt and the Steam Engine,	J. E. Clark.
XII.	Thurs.,	" 16.	Small Arms,	Gen. Wm. B. Franklin.
XIII.	Mon.,	" 20.	The Lesser Bodies of the Solar System,	A. W. Wright.
XIV.	Thurs.,	" 23.	Animal Instinct,	Wm. H. Brewer.

Anniversary.

The anniversary exercises were held in North Sheffield Hall, on the evening of Tuesday, June 29, 1875. Nine theses were selected for public reading.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

CIVIL ENGINEERS. (2)

Samuel Hosmer Chittenden, *Guilford.* On the Railroad Bridge at Omaha.

Lorenzo M. Johnson, *Rochester, Mass.* Design of a Wrought Iron Post Truss Bridge; and a Report upon a Preliminary Survey for the Location of a New Railway Line between Buena Vista and Sound Prairie Stations, Iowa.

DYNAMIC ENGINEERS. (2)

Francis Urquhart Downing, B.A., Ph.B., *New Haven.* On the American Locomotive.

William Hamden Jenks, Ph.B., *Brookville, Pa.* On the Theory of Turbines.

BACHELORS OF PHILOSOPHY. (49)

Charles Henry Alling (Select), *Birmingham.* On the Railroad System of the United States.

Launcelot Winchester Andrews (Chemistry), *Springfield, Mass.* On the *Action of the Alkali Metals* on General Compound Ethers.

*Moses Bradstreet Bradford (Civil Engineering), *Middletown*. On Tidal Drainage.

John Gilbert Bramley (Civil Engineering), *Bovina, N. Y.* Design for a Stone Bridge.

George Loomis Brownell (Civil Engineering), *East Haddam*. On the Iron Truss Bridge over West River.

Amos Avery Browning (Civil Engineering), *Norwich*. On an Improved Form of the Upright Metallic Arch.

Charles Stuart Bunce (Chemistry), *Glastenbury*. On Tungsten.

Frank Taylor Chambers (Dynamic Engineering), *Wilmington, Del.* On the Theory of Iron Ships.

Edward Benjamin Chandler (Civil Engineering), *Woodstock*. On Explosives and their Application in Engineering.

George Rufus Cooley (Civil Engineering), *Hamden*. On the Plane Table.

Chambers McKibbin Craig (Civil Engineering), *Alleghany City, Pa.* On the Present System of Sewerage.

*James Cunningham (Select), *Pittston, Pa.* On the Influence of Geographical Locality on Settlement as Displayed throughout the United States.

Charles William Fenn (Civil Engineering), *Portland, Me.* On the Comparative Compressive Strength of Wrought and Cast Iron.

Charles Hamilton Fox (Select), *Lansingburgh, N. Y.* On Arctic Explorations.

James Freeland (Civil Engineering), *New York City*. On Ventilation.

Luther Henry Gager (Civil Engineering), *Coventry*. On Concrete as a Building Material.

Livingston Gifford (Dynamic Engineering), *Jersey City, N. J.* On the Sewing Machine.

William Cornelius Hall (Civil Engineering), *Buffalo, N. Y.* On the Utilization of Tide Power.

Henry Mortimer Hastings (Civil Engineering), *Oswego, N. Y.* A Review of the Bridge over the Mattabesett River, Berlin, Ct.

Alfred Pell Haven (Civil Engineering), *New York City*. On the Brooklyn Anchorage of the East River Suspension Bridge.

*Charles Hildebrand (Dynamic Engineering), *New Haven*. On Screw Propulsion.

Thomas Douglas Hoxsey (Civil Engineering), *Paterson, N. J.* On the Gunpowder Pile Driver.

William Read Howe (Civil Engineering), *Orange, N. J.* On Tunnels.

*Julian Kennedy (Chemistry), *Struthers, O.* On the Mechanics of Rowing.

Edward Austin Kent (Civil Engineering), *Buffalo, N. Y.* On the Heating of Buildings.

George Reinard Kleeberger (Natural History), *Apple River, Ill.* Plantæ Kelloggianæ et Harfordianæ; an Account of Plants collected by Dr. A. Kellogg and Mr. W. G. W. Harford in California, Oregon, etc., during the years 1868 and 1869.

*Wells Cushman Lake (Dynamic Engineering), *Lake Forest, Ill.* On Iron in Architectural Construction.

Charles Purdy Lindsley (Medical), *New Haven*. On Rhus Toxicodendron.

Blanchard Lynde (Select), *Milwaukee, Wis.* On the History of the Usury Laws of England.

Clarence Fake McMurray, *Lansingburgh, N. Y.* On the Gulf Stream.

Burton Mansfield (Select), *New Haven*. On Immigration into the United States.

John Charles Olmsted (Select), *New York City*. On the Moquis Indians.

*Edward Day Page (Select), *South Orange, N. J.* On the Effect of the British *Poor Laws upon Labor and Wages.*

FREDERIC NOAH PEASE (Chemistry), *Ellington.* On the Decompositions of Rocks due to the Action of Organic Acids contained in Lichens.

*DWIGHT EDWARD PIERCE (Civil Engineering), *New Haven.* On the Niagara Falls Suspension Bridge.

*WILLIAM ARTHUR PRATT (Civil Engineering), *New Haven.* On the Construction and Stability of Dams.

WILLIAM SHUGARD RIGHTER (Dynamic Engineering), *Newark, N. J.* On Quarrying Machinery.

WALTER COE ROBERTS (Dynamic Engineering), *New Haven.* On the Principles of Architectural Construction as Embodied in the Peabody Museum.

RICHARD SHARPE (Dynamic Engineering), *Eckley, Pa.* On Machinery for the Manufacture of Wire Rope.

CLARENCE HOYT STILSON (Civil Engineering), *Cleveland, O.* On the Railway Passenger Depot, New Haven.

JARED SIDNEY TORRANCE (Select), *Gowanda, N. Y.* On Witchcraft as Represented in the Dramatic Literature of the Elizabethan Period.

*FREDERICK MONCRIEFF TURNBULL (Medical), *Hartford.* On the Anatomy of *Nereis Virens.*

ALONZO EARL WEMPLE (Select), *Brooklyn, N. Y.* On the Immediate and the Permanent Effects of the British Orders in Council and of the Napoleonic Decrees upon our Commerce and Industry.

WILLIAM RODMAN WHARTON (Dynamic Engineering), *Germantown, Pa.* On the Transmission of Power by Means of Compressed Air.

ALFRED NEWTON WHEELER (Select), *Southford.* On the Postal System of the United States.

HENRY STACY WHIPPLE (Civil Engineering), *Birmingham.* On the Fourth Avenue Improvement, New York City.

EDWARD LUTHER WHITE (Civil Engineering), *Waterbury.* On the Gilbert Elevated Railway.

GEORGE HORACE WILCOX (Dynamic Engineering), *West Meriden.* On the Meriden Woolen Mill.

KENJIRO YAMAGAWA (Civil Engineering), *Japan.* An Investigation of Curves Formed by the Trigonometric Functions.

PRIZES.

CLASS OF 1875.

For excellence in German, the prize awarded to CHARLES W. FENN, *Portland, Me.*

For excellence in Civil Engineering, the prize awarded to WILLIAM A. PRATT, *New Haven.*

CLASS OF 1876.

For excellence in the Mathematics of Junior Year, the prize divided between PORTER D. FORD, *Washington*, and HIRAM A. MILLER, *New Haven.*

For excellence in Chemistry, the prize divided between FREDERICK P. DEWEY, *West Haven*, and FREDERICK P. MILES, *Salisbury.*

For excellence in Mineralogy, the prize awarded to FREDERICK P. DEWEY, *West Haven.*

CLASS OF 1877.

For excellence in all the Studies of Freshman Year, the prize awarded to WALLACE B. FENN, *New Haven*, with honorable mention of JOSEPH G. CALHOUN, *Hartford.*

For excellence in German, the prize divided between JOSEPH P. IDDINGS, *Orange, N. J.*, and WILLIAM T. SEDGWICK, *Farmington.*

For excellence in Mathematics, the prize divided between JOHN E. BUDDINGTON, *Huntington*, and WALLACE B. FENN, *New Haven.*

For excellence in Physics, the prize awarded to JOSEPH G. CALHOUN, *Hartford.*

For excellence in Mechanical Drawing, the prize awarded to JOSEPH P. IDDINGS, *South Orange, N. J.*

CLASS OF 1873.

For the best Entrance Examination, the prize divided between GEORGE W. MASON, *Orange, N. J.*, and EBEN J. WARD, *Chicago, Ill.*, with honorable mention of CHARLES S. CHURCHILL, *New Haven.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1875--76.

CALENDAR.

1875.		
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.
1876.		**Winter Vacation of two weeks.**
6 Jan.	Thursday,	Second Term begins.
6 April,	Thursday,	Second Term ends.
		Spring Vacation of two weeks.
20 April,	Thursday,	Third Term begins.
27 June,	Tuesday,	Meeting of Appointing Board.
27 June,	Tuesday,	Anniversary.
29 June,	Thursday,	Commencement.
30 June,	Friday,	Examination for Admission.
1 July,	Saturday,	
		Summer Vacation of eleven weeks.
12, 13 Sept.	Tues., Wedn.,	Examination for Admission.
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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Rev. NOAH PORTER, D.D., LL.D.

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APPOINTED BY THE CORPORATION OF YALE COLLEGE.

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Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

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Political Economy and History. (40 N. S. H.) 68 Whitney av.

OSCAR D. ALLEN,
Analytical Chemistry and Metallurgy. (20 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (42 N. S. H.) 148 College st.

SIDNEY I. SMITH,
Comparative Anatomy. (42 N. S. H.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 201 Orange st.

LECTURERS, INSTRUCTORS, AND ASSISTANTS.

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 710 Chapel st.

MARK BAILEY,
Elocution. (150 F.) 185 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art Building.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 28 Clark st.

OSCAR HARGER,
Palæontology. (4 TR.) 14 University pl.

JOSEPH J. SKINNER,
Mathematics. 710 Chapel st.

MANSFIELD MERRIMAN,
Civil Engineering. (46 N. S. H.) 8 Audubon st.

AUGUST H. EDGREN,
French. 189 George st.

HENRY A. HAZEN,
Drawing. (52 N. S. H.) 55 N. S. H.

GEORGE W. HAWES,
Mineralogy. (18 S. H.) 14 S. H.

ALLEN B. HOWE,
Analytical Chemistry. 14 S. H.

SAMUEL F. CLARK,
Zoölogy. 58 N. S. H.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (13 S. H.) 23 Humphrey st.

JULIAN KENNEDY,
Physics. 30 Bristol st.

CHARLES HILDEBRAND.
Mechanical Drawing. 16 Chestnut st.

GRADUATE STUDENTS.

Thomas Marcus Blakslee, PH.B. Madison University.	*Hamilton, N. Y.*	36 Prospect st.
Edward Alexander Bouchet, B.A.	*New Haven,*	42 Bradley st.
Amos Avery Browning, PH.B.	*Norwich,*	136 Crown st.
Clarendon Cobb Bulkley, B.A. Trinity College.	*Lebanon, N. H.*	23 Lyon st.
Orlando Clarke Charlton, B.S. Hanover College, Ind.	*New Albany, Ind.*	390 State st.
Russell Henry Chittenden, PH.B.	*New Haven,*	23 Humphrey st.
Charles Howard Fitch, PH.B.	*New Haven,*	58 Olive st.
Edward Everett Gaylord, B.A.	*Ashford,*	4 Library st.
George Bird Grinnell, B.A.	*New York City,*	6 Library st.
Oscar Harger, M.A.	*New Haven,*	14 University pl.
George Wesson Hawes, PH.B.	*Boston, Mass.*	14 S. H.
Henry Allen Hazen, B.A. Dartmouth College.	*New Haven,*	55 N. S. H.
Charles Hildebrand, PH.B.	*New Haven,*	16 Chestnut st.
Frederick Hodges Hoadley, B.A.	*New Haven,*	109 Elm st.
Allen Brewer Howe, PH.B.	*Troy N. Y.*	14 S. H.
Julian Kennedy, PH.B.	*Struthers, O.*	31 Bristol st.
Robert Fairchild Kedzie, M.S. Michigan Agricultural College.	*Lansing, Mich.*	390 State st.
Calvin Morgan McClung, B.A. East Tennessee University.	*Knoxville, Tenn.*	114 High st.
Mansfield Merriman, C.E.	*Southington,*	8 Audubon st.
Robert Peachy Maynard, B.A.	*San Francisco, Cal.*	193 Temple st.
William Barton Payne, B.A. East Tennessee University.	*Knoxville, Tenn.*	126 Crown st.
Frederick Noah Pease, PH.B.	*Ellington,*	32 Bristol, st.
Claudius Victor Pendleton, PH.B.	*Bozrah,*	57 N. S. H.
William Arthur Pratt, PH.B.	*New Haven,*	8 Gill st.
Holmes Elias Sadler, B.A.	*Buffalo, N. Y.*	
George Henry Seyms, B.A. Trinity College.	*Hartford,*	90 Grove st.
Joseph John Skinner, C.E.	*New Haven,*	710 Chapel st.
Thomas Alexander Smith, B.A. Muskingum College.	*Morganville, O.*	38 High st.
Thomas Berry Smith, B.A. Pritchett Institute, Glasgow, Mo.	*Glasgow, Mo.*	46 York Square Pl.
Frederick Moncrieff Turnbull, PH.B.	*Hartford,*	35 High st.

GRADUATES 30.

UNDERGRADUATE STUDENTS.

SENIOR CLASS.

David Root Alden,	*Westville*,	126 High st.
Halsey Warren Allen,	*Jersey City, N. J.*	63 W. D. H.
Evelyn Marcelon Andrews,	*Norwich*,	22 Trumbull st.
Charles Eben Bacon,	*Middletown*,	525 Chapel st.
Charles Loring Brace,	*Hastings, N. Y.*	90 High st.
Frank Elwood Brown,	*West Haven*,	West Haven.
William McCulloh Brown,	*Brookline, Mass.*	143 York st.
Will C. Browning,	*Norwich*,	90 High st.
Walter Cleveland Butler,	*New Haven*,	113 Olive st.
Lloyd Joseph Caswell,	*Norwich*,	125 High st.
John Henry Chapman,	*New York City*,	46 Elm st.
Sidney Williams Clark,	*Hartford*,	62 W. D. H.
John Moffat Cunningham,	*Poughkeepsie, N. Y.*	62 W. D. H.
Frederick Perkins Dewey,	*West Haven*,	8 Lock st.
George Cornwall Dunham,	*Southington*,	66 Bradley st.
John Sherman Fitch,	*New Haven*,	46 High st.
Stanley Forbes,	*San Francisco, Cal.*	144 Orange st.
Edward Livingston Ford,	*Buffalo, N. Y.*	48 College st.
Porter Dwight Ford,	*Washington*,	125 Dwight st.
Edward Jasper Francke,	*New York City*,	68 W. D. H.
Robert Jackson Gibson,	*New Haven*,	44 Edwards st.
Edward Gillette,	*New Haven*,	15 Columbus st.
Jack Hays Hammond,	*San Francisco, Cal.*	36 Elm st.
James Lawrence Houghteling,	*Chicago, Ill.*	36 Elm st.
Randell Hunt,	*New Orleans, La.*	36 Elm st.
Edward Hine Johnson,	*Brooklyn, N. Y.*	94 Grove st.
James Tewksbury Law,	*Tarrytown, N. Y.*	94 Grove st.
Thomas Howard Linsley,	*West Meriden*,	36 Elm st.
John Francis Luby,	*New Haven*,	21 Nash st.
Albert Sutton Macgregor,	*New York City*,	161 Temple st.
Max Mailhouse,	*New Haven*,	49 Meadow st.
Howard Meyer,	*New York City*,	35 College st.
Frederick Plumb Miles,	*Salisbury*,	64 W. D. H.
Hiram Allen Miller,	*New Haven*,	133 College st.
William Mayo Newhall,	*San Francisco, Cal.*	36 Elm st.
John Robert Paddock,	*Cheshire*,	88 Wall st.
William Beach Palmer,	*Bridgeport*,	61 W. D. H.
Edward Larned Ryerson,	*Chicago, Ill.*	36 Elm st.
William Babcock Sawyer,	*Buffalo, N. Y.*	191 Temple st.
Charles David Seeberger,	*Chicago, Ill.*	133 College st.

Andrew Gilbert Sheak,	*Binghamton, N. Y.*	525 Chapel st.
Gordon Edward Sherman,	*Morristown, N. J.*	36 Elm st.
Thomas Ewing Sherman, B.A. Georgetown College.	*St. Louis, Mo.*	36 Elm st.
George Watson Smith,	*Chicago, Ill.*	36 Elm st.
LeGrand Smith,	*Chicago, Ill.*	36 Elm st.
Francis Augustus Terry,	*Lyme,*	71 W. D. H.
Frederick William Vanderbilt,	*New York City,*	35 College st.
Charles William Van Vleck,	*Cincinnati, O.*	37 College st.
Charles Alexander Watson,	*Hartford,*	90 High st.
David Agnew Weyer,	*Madison, Ind.*	169 Temple st.
Frederick Wood,	*Norwalk,*	191 Temple st.
Thomas Yeatman,	*New Haven,*	36 Elm st.

SENIORS, 52.

JUNIOR CLASS.

William Whittlesey Abbott,	*Yarmouth, Me.*	29 Prospect st.
William Henry Backus,	*Cleveland, O.*	65 W. D. H.
George Henry Bartlett,	*North Guilford,*	157 Church st.
Charles Coffing Beach,	*Hartford,*	159 Temple st.
Morris Burke Belknap,	*Louisville, Ky.*	14 Lock st.
Bernard Berens,	*Philadelphia, Pa.*	42 Grove st.
Arthur Lewis Betts,	*Norwalk,*	Westville.
Frank Lewis Bidwell,	*Kansas City, Mo.*	64 W. D. H.
John Edwards Buddington,	*Huntington,*	Huntington.
Lucien Lowber Burrows,	*Decatur, Ill.*	120 High st.
Herman Beardsley Butler,	*New York City,*	36 Elm st.
Joseph Gilbert Calhoun,	*Hartford,*	56 W. D. H.
Alfred Chapman,	*Bethel,*	99 Wall st.
Frederick Leonard Cowles,	*New Haven,*	632 Chapel st.
Henry Holbrook Curtis,	*New York City,*	251 Church st.
Judson Amos Doolittle,	*Cheshire,*	88 Wall st.
Wallace Bruce Fenn,	*New Haven,*	191 Church st.
Burr Kellogg Field,	*Germantown, Pa.*	157 George st.
Joachim John Francke,	*New York City,*	68 W. D. H.
William Edgar Gard,	*New York City,*	116 W. D. H.
Charles Cartledge Godfrey,	*Southport,*	41 College st.
John Elisha Morpeth Hall,	*Brooklyn, N. Y.*	46 York sq. pl.
William Torrence Handy,	*Cincinnati, O.*	159 George st.
William Stanley Hine,	*Bridgeport,*	Bridgeport.
Walter Holcomb,	*New Hartford,*	73 Trumbull st.
William Coe Holmes,	*Waterbury,*	153 Crown st.
Horace Cobb Howard,	*Townsend, Vt.*	8 Lock st.
Joseph Paxon *Iddings,*	*Orange, N. J.*	119 W. D. H.

Charles Maples Jarvis,	*Binghamton, N. Y.*	65 W. D. H.
Lawrence Kneeland,	*Brooklyn, N. Y.*	153 Crown st.
Elijah Thien Foh Laisun,	*Shanghai, China,*	226 Church st.
Frank Cooper Lawrence,	*New York City,*	488 Chapel st.
Alton Winslow Leighton,	*New Haven,*	137 Henry st.
Charles James Luck,	*Rouse's Point, N. Y.*	44 York sq. pl.
Ferrier John Martin,	*Orange, N. J.*	70 W. D. H.
Charles Knox Mixter,	*Rock Island, Ill.*	116 W. D. H.
Charles Arthur Montjoy,	*Lambayeque, Peru,*	15 Home pl.
James Blair Murray,	*Norwich,*	125 Dwight st.
Samuel Lewis Penfield,	*Catskill, N. Y.*	58 Trumbull st.
Willard Nourse Platt,	*Elmira, N. Y.*	48 College st.
Nathaniel Chapin Ray,	*West Haven,*	271 Chapel st.
Francis Rawlinson Read,	*Hartford,*	90 High st.
James Tracey Richards,	*Stratford,*	61 W. D. H.
Lucius Waterman Robinson,	*Fair Haven,*	255 Ferry st.
Thomas Weaver Rogers,	*Brooklyn, N. Y.*	8 Lock st.
Thomas Fitch Rowland,	*Greenpoint, N. Y.*	92 Chapel st.
Everett Rushmore,	*Mamaroneck, N. Y.*	161 Temple st.
James Alvin Scott,	*Naugatuck,*	1 Whalley av.
William Thompson Sedgwick,	*Farmington,*	4 Library st.
Charles Dwight Smith,	*Plantsville,*	133 College st.
George Smith,	*New Haven,*	164 Elm st.
Walter Snowdon Smith,	*Cincinnati, O.*	458 Chapel st.
Henry Ling Taylor,	*New York City,*	58 W. D. H.
Arthur John Tenny,	*New Haven,*	126 Crown st.
Allan Mason Thomas,	*Wickford, R. I.*	193 Temple st.
William Gilman Thompson,	*New York City,*	251 Church st.
John Abeel Weekes,	*New York City,*	161 Temple st.
Horace Lemuel Wells,	*New Britain,*	66 Bradley st.
James Harold Wickersham,	*Lancaster, Pa.*	165 Temple st.
David Willard Williams,	*Glastenbury,*	136 Crown st.
Albert Daniel Wilson,	*Newburg, N. Y.*	42 Grove st.
George Leverett Wilson,	*West Killingly,*	8 Lock st.
Edwin Young,	*Homesdale, Pa.*	251 Church st.

JUNIORS, 63.

FRESHMAN CLASS.

Frederick Innis Allen,	*Auburn, N. Y.*	35 High st.
William Day Allen,	*Hartford,*	84 Wall st.
Seymour Landon Alvord,	*West Winsted,*	193 Temple st.
John Pomeroy Bartlett,	*New Britain,*	88 Wall st.
John Luis Blackmore,	*City of Mexico, Mexico,*	40 Park st.
Edward Everett Brewster,	*West Cornwall,*	79 Chapel st.
Thomas Deloss Bristol,	*Harwinton,*	Fair Haven.
Fayette Williams Brown,	*Yonkers, N. Y.*	133 College st.
William Tyler Browne,	*Lisbon,*	175 George st.
Charles William Canfield,	*Hartford,*	81 Wall st.
Robert Williams Chapin,	*Springfield, Mass.*	162 York st.
William Grover Chapin,	*Somers,*	44 York sq.
Charles Samuel Churchill,	*New Haven,*	257 Franklin st.
Walter Linsley Cowles,	*Wallingford,*	432 Chapel st.
William Sidney Downs,	*Birmingham,*	Birmingham.
Charles Augustus Dwinelle,	*New York City,*	18 Grove st.
Edward Caldwell Earle,	*New Haven,*	214 Orchard st.
Levi Abraham Eliel,	*Chicago, Ill.*	523 Chapel st.
Augustus James Emery,	*Bangor, Me.*	547 Howard av.
Granger Farwell,	*Chicago, Ill.*	41 College st.
Oswin Hart Doolittle Fowler,	*North Haven,*	432 Chapel st.
Allan Murray Gale,	*New Haven,*	87 Trumbull st.
John Currier Gallagher,	*New Haven,*	21 Olive st.
Jonathan Godfrey,	*Southport,*	41 College st.
William Augustus Goodman,	*Cincinnati, O.*	464 Chapel st.
Cadmus Zaccheus Gordon,	*Brookville, Pa.*	8 Lock st.
Rodney Granger,	*Chicago, Ill.*	41 College st.
Leonard Vassall Greene,	*Norwich,*	134 College st.
Ralph Augustus Harman,	*Cleveland, O.*	114 College st.
Gerald Waldo Hart,	*New Britain,*	124 High st.
Walter Tillman Hart,	*New Haven,*	44 High st.
George Stewart Hegeman,	*Brooklyn, N. Y.*	156 York st.
Frank Eugene Hemingway,	*New Haven,*	122 Park st.
Charles Betts Hillhouse,	*New Haven,*	3 Hillhouse av.
Charles DeVilliers Hoard,	*Chicago, Ill.*	416 Chapel st.
Robert Samuel Hulbert,	*West Winsted,*	193 Temple st.
Thomas Mastin Jacks,	*Helena, Ark.*	8 Elm st.
Fred Beckwith Jillson,	*Whitehall, N. Y.*	83 Olive st.
Willard Drake Johnson,	*Washington, D. C.*	23 Prospect st.
John Philbrick Laflin,	*Chicago, Ill.*	114 High st.
Effingham Lawrence,	*New Orleans, La,*	464 Chapel st.
Edward Charless LeBourgeois,	*St. James Parish, La.*	464 Chapel st.
Charles Richard Lee,	*Kenosha, Wisc.*	31 S. D. H.
Arthur Lyman,	*Leominster, Mass.*	116 College st.
Elbert Baldwin Mann,	*Rochester, N. Y.*	15 Home pl.

George Webb Mason,	*Orange, N. J.*	119 W. D. H.
Frank Peterson Mitchell,	*Cincinnati, O.*	84 Wall st.
James Philip Montjoy,	*Lambayeque, Peru,*	258 Orange st.
William James Perry Moore,	*New Britain,*	79 William st.
Frank Turner Moorhead,	*Pittsburgh, Pa.*	459 Chapel st.
Frank Pierce Morrison,	*Santa Clara, Cal.*	61 Grove st.
Frank Tracy Watkins Palmer,	*Chicago, Ill.*	464 Chapel st.
Henry Grenville Parkin,	*New York City,*	84 Wall st.
Robert Wilson Patrick,	*Omaha, Nebr.*	531 Chapel st.
James Henry Pierce,	*Santa Clara, Cal.*	61 Grove st.
George Henry Potts,	*Pittstown, N. J.*	133 College st.
William Eckhardt Raht,	*Cleveland, Tenn.*	8 Lock st.
Edward Townsend Reed,	*Albany, N. Y.*	15 Home pl.
Charles Theodore Richmond,	*Johnsonville, N. Y.*	83 Olive st.
Edward Kilbourn Roberts,	*New Haven,*	8 Brown st.
Harold Roorbach,	*New York City,*	12 Home pl.
Edward Hubbard Russell,	*New Haven,*	11 Wooster pl.
Rufus Henry Skeel,	*Newburgh, N. Y.*	23 Prospect st.
Edward Herndon Smith,	*Brooklyn, N. Y.*	133 College st.
Thaddeus Henry Spencer,	*Suffield,*	69 Bradley st.
William Annin Vliet,	*Cleveland, O.*	133 College st.
George Augustus Wall,	*Providence R. I.*	162 York st.
Ebin Jennings Ward,	*Chicago, Ill.*	523 Chapel st.
Walter Watson,	*Northampton, Mass.*	90 Grove st.
Caryl Fenelon Seely White,	*New Haven,*	104 York st.
Eugene Benjamin Wilson,	*Elizabeth, N. J.*	Milford.
Francis Dana Winslow,	*Washington, D. C.*	165 Temple st.
William Hopkins Young,	*Poughkeepsie, N. Y.*	161 Temple st.

FRESHMEN, 73.

SPECIAL STUDENTS NOT CANDIDATE FOR A DEGREE.

Henry Staveley Andrews,	*Sussex, England,*	37 Clark st.
Francis Batcheller,	*Boston, Mass.*	30 Trumbull st.
Thomas Attwater Bostwick,	*New Haven,*	162 Olive st.
Luther Chamberlain Bragg,	*Milford, Mass.*	27 Prospect st.
Frank Caldwell,	*Carthage, O.*	58 W. D. H.
Samuel Fessenden Clark,	*Geneva, Ill.*	58 N. S. H.
Clinton Hart Merriam,	*Locust Grove, N. Y.*	42 Whitney av.
Henry Pierce Morgan,	*Woodbridge,*	Woodbridge.
Arthur Edward Nichols,	*Yonkers, N. Y.*	165 Temple st.
George Leland Upham,	*Yonkers, N. Y.*	191 Temple st.
Thomas Alfred Vernon,	*Brooklyn, N. Y.*	205 Orange st.
Edward Beecher Wilson,	*Geneva, Ill.*	27 Prospect st.

SPECIAL STUDENTS, 12.

SUMMARY.

Graduates,	30
Seniors,	52
Juniors,	63
Freshmen,	73
Special Students,	12
Total,	230

SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture

and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Building and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the school:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of *Mechanical Apparatus*, constituting the "Collier Cabinet."

7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

The Library.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and six years ago purchased and presented to the Institution by Mr. Sheffield. A Catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870.

The following scientific journals are received regularly at the Library, and are accessible to all for consultation.

AMERICAN.

Journal of the Franklin Institute.
Engineering and Mining Journal.
Scientific American.
Mining and Scientific Press.
Van Nostrand's Eclectic Engineering Magazine.
Railroad Gazette.
Bulletin of the National Association of Wool Manufacturers.
American Chemist.
American Journal of Science.

ENGLISH.

Agricultural Gazette, The.
Annals and Magazine of Natural History.
Builder, The.
Economist, The.
Engineer, The.
Engineering.
Farmer's Magazine.
Garden, The.
Gardiner's Chronicle, The.
Grevillea.

Iron.
Journal of the Anthropological Institute.
——— of the Chemical Society.
——— Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chimique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für reine und angewandte Mathematik.
Landwirthschaftliche Jahrbücher.
Milch-Zeitung.
Nachrichten, Astronomische.
Polytechnisches Journal, Dingler's.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftliche Zoologie.
Zeitung, Berg-und Hüttenmännische.
———, Botanische.

Niederländisches *Archiv für Zoologie.*

Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a much larger number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical *instruments, and in* astronomical spectroscopy.

Professor TROWBRIDGE, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMICAL ENGINEER will comprise

1. Higher Calculus, General Theory of equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics.) Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

Requirements for Admission.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects;

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Arithmetic—including the Metric System.
Algebra—Davies' Bourdon, or Loomis's Treatise, as far as the general theory of equations; or an equivalent.
Geometry—Chauvenet's Geometry; or an equivalent.
Plane Trigonometry—an equivalent to Loomis's Plane Trigonometry, or to the Plane and Analytical Trigonometry of Davies' Legendre.
(In the examinations of 1877, Snowball and Lund's Course of Elementary Natural Philosophy* will be required.)

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, June 30, July 1; and on Tuesday and Wednesday, September, 12, 13, 1876. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree later than at the beginning of the Senior year.

For the guidance of students purposing to enter this institution, the following information is furnished in regard to the requirements in certain studies; not necessarily because the subjects mentioned are of any more importance in themselves, but because experience has shown that they are the subjects in which candidates are generally apt to be to a greater or less extent deficient.

* *Published by Macmillan & Co.*, London and New York.

Arithmetic.—The examination in this study will embrace the leading topics taught in the high schools of the country. It will extend to the rationale of arithmetical processes as well as to the processes themselves; and candidates should, therefore, have carefully reviewed the subject, after having attained sufficient maturity to comprehend it.

Algebra.—The following subjects will receive special attention in the examination in this branch:

The fundamental operations upon both entire and fractional expressions, including factoring; the solution of equations of the first and second degree; the reduction of inequalities; the theory of fractional and negative exponents, and the calculus of radicals; the application of the binomial formula, whatever be the exponent; the method of indeterminate co-efficients; and the theory and use of logarithms. There is far too often a general want of thoroughness in the preparation of candidates in this fundamental branch of mathematical analysis.

Geometry.—In this subject the candidate should have in his preparation a sufficient number of not too difficult exercises in geometrical invention, such as can be chosen from the works of Loomis, Chauvenet, Tappan, and Olney, and further found in abundance in various English and other foreign collections. Particular attention should also be paid to exercises in the elementary formulæ of mensuration.

Trigonometry.—In Trigonometry it is absolutely requisite that the candidate make himself thoroughly familiar with the deduction of the formulæ, with the use of the trigonometrical tables, and the solution of plane triangles. He should besides be exercised as far as practicable in simple trigonometrical transformations. Todhunter's "Trigonometry for Beginners" will furnish abundant material for this class of exercises. In his Trigonometrical calculations, as in all others, he should study the art of neat and orderly arrangement, as an important means to a valuable end. If the use of Logarithms is postponed till this subject is taken up (which is by no means advisable), it should embrace all forms of calculation occurring in ordinary practice, as well as those appearing in the solution of triangles; since any one of the former is liable at any time to appear in the work given in the examinations.

Latin.—In order to assure the attainment of the required proficiency in this study, the student should have such continued training in parsing as shall make him thoroughly familiar with

declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements the requirement has been adopted of "simple exercises in prose composition." By this is meant, merely, such a course of elementary exercises in translating, orally and, in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature or the extent of the requirement the following works are specifically named, among which the candidate for examination may make his own election. These are Harkness' "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; or McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

VII.

Instruction for Undergraduate Students.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining and Metallurgy;
(h.) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM. — *German*, — Whitney's Grammar and Reader. *English*, — Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*,—Plane Analytical Geometry. *Physics*,—Atkinson's Ganot, with experimental lectures. *Chemistry*,—Eliot and Storer's Manual: Laboratory practice. *Elementary Drawing*,—Practical Lessons in the Art School.

SECOND TERM.—*Language, Physics, Chemistry, and Drawing*.—As stated above. *Mathematics*,—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation. *Physical Geography*,—Lectures.

THIRD TERM.—*German and Physics*,—As stated above. *Mathematics*,—Analytical Geometry in Space; Spherical Trigonometry. *Botany*,—Gray's Lessons. Lectures. *Polit. Economy*,—Elementary Lectures. *Drawing*.—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Qualitative Analysis*,—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM.—*Laboratory Practice*,—Qualitative Analysis, continued. Quantitative Analysis, begun. *Mineralogy*,—Blowpipe Analysis and Determination of Species. *Zoology*,—Lectures. *German. French.*

THIRD TERM.—*Laboratory Practice*,—Quantitative Analysis, continued. *Mineralogy*,—Lectures. *Zoology*,—Lectures and Excursions. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Laboratory Practice*,—Volumetric and Organic Analysis. *Geology*,—Dana's. *Zoology*,—Lectures. Excursions. *French.*

SECOND TERM.—*Laboratory Practice*. Mineral Analysis and Assaying. *Agricultural Chemistry*,—Recitations and Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *French. Zoology*,—Lectures.

THIRD TERM.—*Laboratory Practice*. Preparation of Thesis. *Agricultural Chemistry*,—Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*,—Lectures.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics*,—Differential and Integral Calculus. Descriptive Geometry. *Surveying*,—Field Operations. *Drawing*,—Binns' Orthographic Projections. *German. French.*

SECOND TERM.—*Mathematics*,—Integral Calculus. Rational Mechanics. *Drawing*,—*Projection of Shadows* and Perspective. *German. French.*

THIRD TERM.—*Mathematics.* Rational Mechanics. Descriptive Geometry. Warped Surfaces. *Surveying*,—Topographical. *Drawing*,—Topographical. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Field Engineering*,—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*,—Mahan's *Stone Cutting*,—with graphical problems. *Geology*,—Dana's. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Drawing*,—Architectural and Structural. *French.*

SECOND TERM.—*Civil Engineering*,—Resistance of Materials. Bridges and Roofs. Building Materials. *Astronomy*,—Loomis's Astronomy, with practical problems. *Mineralogy*,—continued. *Geology*,—Dynamic. *French.*

THIRD TERM.—*Civil Engineering*,—Bridges and Roofs. Stability of Arches and Walls. *Dynamics*,—Principles of Mechanism. Steam Engine. *Hydraulics*,—Hydraulics and Hydraulic Motors.

(c.) IN DYNAMICAL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—Analytical Geometry of three Dimensions. Differential Calculus. Descriptive Geometry. Instrumental Drawing. *German. French.*

SECOND TERM.—Differential and Integral Calculus. Instrumental Drawing. *German. French.*

THIRD TERM.—*Mechanics.* Binns' Second Course of Drawing, including drawing of gearing, perspective, shades and shadows, tinting, construction of warped surfaces, and isometric drawing. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Drawing*,—Construction of Machines from actual measurements in the shops. *General Theory of Motion*,—Applications of this theory to the motion of bodies, and to the motions of parts of machines. *General Theory of Gearing*,—Cams, connections by bands, links, cords, and hydraulic connections. General principles of trains of mechanism. Mechanical powers. Aggregate combinations in mechanism (Rankine). *Theory of Valve Motions* (Zeuner). *Applied Mechanics*,—Machinery and mill work. Dynamics of Machinery (Rankine), begun. *French. Geology.*

SECOND TERM.—*Applied Mechanics*,—continued. *Dynamics of Machinery.*—Theory of Machines.—Special applications of the Theory of Machines to problems involving the efficiency of machines and to special machines. *Materials used in construction*, their composition and qualities, iron, steel alloys, wood, animal substances. Drawing (construction of machines), continued. *Theory of Elasticity*,—Principles of construction of roof-trusses, beams, girders, and bridges. Principles relating to resistance to torsion of shafts, to shearing, and to stiffness and stability of structures. (Rankine.) *Heat*,—General principles. Application of principle of specific heat. Action of bodies under the influence of heat. Change of states of aggregation. Expansion. *Applications of* law of Mariotte and Gay Lussac. Gases. *Vapors, Laws of expansion. Densities.* Elastic force of gases and vapors.

Quantities of heat. Latent heats of fusion and evaporation. *Combustion*,—Quantities of air required, nature of products, heat evolved. *Fuel*,—Kinds and quantities transfer of heat. *Description of Steam Generators*,—Principles of construction of steam generators. *Geology. French.*

THIRD TERM.—*Prime Movers in General*,—Animal Mechanics, water powers, heat engines, regulators, dynamometers, valves, brakes, fly-wheels, governors, measurement of friction, &c. *Water power Engines*,—Sources of water power, measurement of supply. Construction of conduits. Measurements of flow. Hydraulic press. Water pressure engines. *Water Wheels*,—Overshot, undershot, and breast wheels. Reaction wheels. Turbine wheels. Wind power. *Heat Engines*,—Principles of thermodynamics. Air engines. Steam engines. Efficiency of steam and air engines. Mechanism of steam and air engines. Drawing of structures. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Experimental and Analytical Chemistry*,—in their Agricultural applications. Laboratory Practice. *Physical Geography. Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *English. German. French.*

SECOND TERM.—*Agricultural Chemistry*,—Recitations. *Experimental Chemistry*,—Laboratory Practice. *Physical Geography. Mineralogy.* Lectures. *English. German. French.*

THIRD TERM.—*Agricultural Chemistry*,—Lectures. *Horticulture and Kitchen Gardening*,—Lectures. *Experimental Chemistry*,—Laboratory Practice. *Botany and Zoology*,—with Excursions. *Mineralogy*,—continued. *English. German. French.*

SENIOR YEAR.

FIRST TERM.—*Agriculture*,—Cultivation of the Staple Crops of the Northern States. *Agricultural Zoology*,—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. *Geology*,—Dana's. *English. French. Excursions*,—Agricultural, Botanical, etc.

SECOND TERM.—*Agriculture*.—Stock raising and principles of Breeding. *Geology*,—Dana's. *Human Anatomy and Physiology*,—Lectures. *English French.*

THIRD TERM.—*Rural Economy*,—History of Agriculture and Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *Geology*,—Dana's. *English.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Botany*,—*Gray's Text-book; Use of the Microscope.* German. French.

SECOND TERM.—*Zoology*,—Laboratory Practice. *Physiology*,—Huxley's. *Botany*,—Laboratory Practice: Gray's Text-book. *Mineralogy*,—Lectures. *Physical Geography*. *German*. *French*.

THIRD TERM.—*Zoology*,—Laboratory Practice. Lectures, Excursions (land and marine). *Botany*,—Practical Exercises, Excursions. *Mineralogy*,—continued. *German*. *French*.

SENIOR YEAR.

FIRST TERM.—*Geology*,—Dana's. Excursions. *Anatomy of Vertebrates*,—Huxley's. *Zoology*,—Laboratory Practice. Lectures. Excursions. *Botany*,—Herbarium Studies. Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *French*.

SECOND TERM.—*Geology*,—Dana's. *Zoology*,—Laboratory Practice. Lectures. *Botany*,—Herbarium Studies. Cryptogamic plants. Botanical Literature. Essays in Descriptive Botany. *Linguistics*,—Whitney's Language and the Study of Language. *French*.

THIRD TERM.—*Geology*, *Zoology*, *and Botany*—continued, with Excursions. *Meteorology*. *French*.

Besides the regular courses of recitation and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoology and Botany. Attention will be paid in Zoology to comparative anatomy, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The order of studies is as follows:

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis, Fresenius'. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM.—*Physiological Chemistry*,—Klein's Handbook. Laboratory Practice. Recitations. *Physiology*,—Huxley's. *Mineralogy*,—continued. *German*. *French*.

THIRD TERM.—*Physiological Chemistry*,—Klein's. Laboratory Practice. Recitations. *Zoology*,—Lectures and Excursions. *Botany*,—Lectures, Practical Exercises and Excursions. *Mineralogy*,—continued. *German*. *French*.

SENIOR YEAR.

FIRST TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Anatomy of Vertebrates*.—Huxley's. *Botany*,—Practical Exercises, Lectures, and Excursions. *Geology*,—Dana's. *Zoology*,—Lectures and Excursions. *French*.

SECOND TERM.—*Comparative Anatomy and Systematic Zoology*,—Lectures. Laboratory Practice. *Botany*,—Lectures. Laboratory Practice. *Geology*,—Dana's. *French*.

THIRD TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Zoology, Botany, and Geology*,—continued, with Excursions.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM.—*Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. Physical Geography. English*,—Early English. *History*,—Freeman's Outlines. *French. German.*

SECOND TERM.—*Mineralogy*,—Lectures. *Astronomy. Physical Geography. English*,—Chaucer, Shakespeare. *History*,—Freeman's Outlines, with Lectures. *German. French.*

THIRD TERM.—*Botany and Zoology*,—Lectures and Excursions and Laboratory Practice. *English*,—Shakespeare. *Political Economy*,—Walker's Science of Wealth. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology*,—Recitations and Excursions. *Botany*,—Lectures, Excursions and Laboratory Practice. *Zoology*,—Lectures and Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *English*,—Shakespeare. *History*,—Constitutional History of the United States. Lectures. *Political Economy*,—Lectures. *French.*

SECOND TERM.—*Geology and Zoology*,—continued. *Linguistics*,—Whitney's Language and the Study of Language. *Political Economy*,—Lectures. *English*,—Shakespeare and Milton. *History*,—Political History of the United States. Lectures. *French.*

THIRD TERM.—*Geology*.—Recitations and Excursions. *Zoology*,—Lectures. *Meteorology. English*,—Dryden and Pope. *History*,—Lectures. History of Europe since 1848. *Political Economy*,—Lectures.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduation theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given.

Drawing.

The course in drawing extends through the three years. During the first term, and half of the second term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second half of the year, in the elementary principles of instrumental drawing, embracing the whole of Binn's first course of orthographic projections, and Descriptive Geometry as far as warped surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces Binns' second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey,

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VIII.

Methods of Instruction.

The instructions of this institution are given chiefly in small class rooms, recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice *in writing* characters and descriptions of *plants from living specimens.* Students are shown also the best

methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, &c. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of Marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

IX.

Tuition Charges.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. An additional charge of $5 is annually made to each student for *the use of the* College Reading Room and Gymnasium.

After the present year a fee of $5 a term will be charged to the *students in the Zoological* Laboratory.

X.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 42, in the North Gallery.

In the Trinity Church (Epis.): Pews Nos. 175 and 177, in the North Gallery.

In the First Methodist Church: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

XI.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on pages 19 and 20.

3. Doctor of Philosophy: The requirements for this degree are stated on page 18.

XII.

Terms and Vacations.

The next academic year begins Thursday, September 14, 1876. The vacations correspond with those of the Academical Department, giving two weeks at Christmas, two weeks in the Spring, and eleven *weeks in the Summer.*

XIII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 27, 1876, and at or about the same time in the year 1877, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 27, 1876, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

TWELFTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1877-78.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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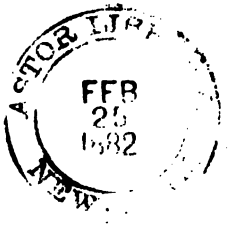

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors of the Sheffield Scientific School have discharged their duties for the current year, and take pleasure in testifying to the admirable condition and efficiency of the institution, and to the rapid advance which it is making from year to year under its very able and energetic managers. It is an honor to the State, not only as a most distinguished school of higher education in the arts and sciences, but as contributing, even in an economic point of view, to the development and prosperity of our material industries.

The State has twenty-seven free scholarships in this school, to which, when applications are in excess of this number, the Governing Board of the school have been accustomed, as matter of courtesy, to allow three more. These are awarded by the Appointing Board to young men fitting themselves for agricultural, mechanical or manufacturing occupations, by preference to orphans of parents who decease in the naval or military service of the United States, and next to such as are in need of pecuniary assistance in fitting themselves for the above named pursuits. By law they are to be distributed among the several counties of the State according to population. Either through ignorance of these noble provisions, or for some cause less creditable, some of the counties of the State are not only without their proper proportional representation in the school, but without any representation at all. These scholarships, for want of other applicants, are largely shared by the people of New Haven county, who have the good sense to appreciate what the people of too many other counties seem to ignore or undervalue. That such opportunities of higher popular education in one of the most accomplished scientific schools in the country, offered without money and without price, should almost go a-begging here in Connecticut, is not *altogether creditable* to the State. The Board of

Visitors take this occasion through the Legislature to remind the people of the State that there are twenty-seven gratuitous scholarships in this school which belong to them, and that they are to be had by deserving applicants for the asking.

The endowment held by the Commissioner of the School Fund for the use of the Sheffield Scientific School, originally invested in United States bonds, was, in 1866, directed to be invested in State bonds. Nineteen ($19,000) of these bonds were redeemed by the State in June last. The Commissioner, doubtful of his authority to reinvest, caused the proceeds to be placed on deposit at 4 per cent. interest. This has resulted in a partial loss of income to the fund. This loss the State is, by the terms of the act of Congress conferring the fund and of the act of the State accepting it, bound to repair. We recommend the immediate investment of the fund at the highest rate of interest consistent with its safety, and that the State meantime make good the shrinkage of revenue arising from failure to reinvest.

The report of the Governing Board of the school, which is hereto annexed, will supply the Assembly with all needed information in regard to the condition, progress and working of the institution.

By order of the Board of Visitors,

R. D. HUBBARD,
President.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

The Eleventh Annual Report of the Sheffield Scientific School was presented to the Legislature in June, 1876, and embraced the history of the institution during the twelve months immediately preceding. In consequence of the change which had taken place in the time of meeting of the Legislature, no inspection by the State Board of Visitors had been made in the short time which had elapsed between the two sessions of the legislative assembly; and the Governing Board of the School were advised by the then Governor to submit their next report at the opening of the session in January, 1878. The twelfth Annual Report will accordingly embrace an account of the School during the last half of the year 1876, and the whole of the year 1877.

The Peabody Museum.

At the date of the last Report, it was mentioned that the instruction in Mineralogy had at that time been already transferred to the Peabody Museum. This was soon followed by the transfer of the instruction given in various other departments. In the autumn of 1876, the laboratories of Biology (including Zoology and Comparative Anatomy), as well as the laboratories of Geology and Mineralogy, were opened, and from that time all the instruction given by the School in these various subjects has been carried on in the Museum.

Change in the Corps of Instructors.

It is with great regret that the Governing Board are under the necessity of announcing the loss from the corps of instructors of Professor William P. Trowbridge, who in 1877 accepted the position *of head of the Engineering* Department of Columbia

College, N. Y., and in consequence resigned the chair of Dynamic Engineering, of which he was the first incumbent. His place was filled at the commencement of 1877 by the election of A. Jay DuBois, who was at that time Professor of Civil Engineering in Lehigh University. Mr. DuBois was graduated at the Sheffield Scientific School in 1869, and pursuing in it for the four following years courses of graduate study, received in 1870 the degree of Civil Engineer, and in 1873 that of Doctor of Philosophy. He subsequently spent two years in Europe in the further prosecution of his special engineering studies, and on his return to this country was called to the chair of Civil Engineering in Lehigh University, and during his connection with that institution wrote a treatise on Graphical Statics, and translated and edited the second volume of Weisbach's Mechanics.

Instruction in Biology as a Preparation for Medical Studies.

The course in Biology, as a preparation for Medical Studies, has now attained to such dimensions, and has proved so decided a success, that it seems eminently proper that in this Annual Report an account should be given of its origin and history, and the objects which it was destined to fulfill. The insufficiency of the preparation of most of the students who attend our medical schools and the generally admitted low standard of medical education, resulting very largely from this want of preparation, had early attracted the attention of the Governing Board and led them, after considerable deliberation, to arrange, and to announce in the Annual Report for 1869–70, a new course of instruction intended specially to provide efficient preparation for medical studies. Several students at once availed themselves of the opportunity thus offered, and in 1872, two were graduated and at once entered upon their strictly professional studies. Since the first announcement important changes have, from time to time, been made in the instruction given, and there has been a constant increase in the number of regular undergraduate students taking the course, while a considerable number of graduate and special students have pursued the whole or a part of the studies prescribed. Still it is believed that the advantages of such a course of study are not so well nor so widely understood as they deserve to be, and that it is desirable that a fuller statement of the aim and object of the course should be made.

That some preparation beyond that usually acquired at the "common school" is needed for profitable entrance upon medical studies is taken for granted. Even those medical schools which practically require no examination for entrance, usually recognize this in the shortening of the required term of study for those students who have received a baccalaureate degree. In one sense, any course of study, in as much as it is disciplinary, is a preparation for medical as well as for any other studies, but no argument is needed to show that purely mental training, which may be the best preparation for theological or legal studies, for instance, is a very imperfect preparation for the study of medicine. As a rule, the student while at the medical school has very little time or opportunity for the training of the senses and the acquisition of the power of accurate observation which are so evidently requisite in the practice of medicine or surgery. And if this special training is essential to the successful practice of medicine, it is also an almost indispensable aid in the acquisition of the technical knowledge and skill required of the practitioner. The training which is to furnish the special discipline for the practice of medicine or surgery should therefore as largely as possible precede the medical studies themselves. The study of the methods of modern scientific investigation and their practical application in the laboratory, unquestionably furnish the best and readiest means for this kind of training. A still more apparent advantage of this class of studies is that they may readily be made to furnish the best groundwork for the special medical education. The shortness of the usual term of instruction in the medical schools does not allow the introduction of even the most essential preliminary studies, so that the ordinary student is often forced to take up studies which he is not qualified to pursue. As an illustration, a thorough acquaintance with the elements of physics and chemistry is essential for understanding the first principles of physiology, and yet neither physics nor chemistry has properly any place in the curriculum of the medical school, and cannot well be taught the student already grappling with subjects presupposing a knowledge of them. The elements of these important studies should be mastered before the medical school is entered, and when studied practically in the laboratory, as only they can properly be studied, they also give training in scientific method and manipulation, which is so essential both to the student and practitioner *of medicine.*

There is no necessity for discussing the need of general literary and scientific studies in a course of preparation for the medical school. In the Scientific School such studies run through all the courses of instruction and are made obligatory upon all students. The knowledge of German and French thus acquired is also of special additional value to the medical student by enabling him to make use of the important technical works in those languages.

A brief outline of the course of instruction in biology as now conducted is given in the Programme of Studies accompanying this Report, but a somewhat fuller explanation of that portion of the instruction bearing particularly upon medical pursuits may properly be given here. During the first year, which is introductory to all the courses, besides German, English and mathematics, the student has recitations and experimental lectures in physics, elementary chemistry with practical work in the laboratory, elementary drawing, and elementary botany, and also lectures on physical geography and political economy. With the second year the special biological studies begin, and during the rest of the course the student spends a portion of each day in practical work in the laboratory.

During the entire second year the laboratory work for five days in the week is confined exclusively to chemistry: the first term to inorganic, the second to physiological and toxicological chemistry. At the beginning of the year the student who, from his study of elementary chemistry is prepared to enter understandingly upon a course of laboratory work, is taught the reactions of the different elements of inorganic matter and to verify by actual observation the statements made in the text book concerning the elements studied. Thus habits of observation, so important to a medical man, are formed and the power of tracing to their rightful sources many of the phenomena of nature, together with a knowledge of inorganic chemistry, is acquired: a necessary step preceding the more important study of the chemistry of the body. After a certain amount of work has been performed in the study of reactions, unknown substances are given the student to analyze, thus calling into use the knowledge acquired and familiarizing him with the *modus operandi* of qualitative analysis while at the same time habits of self-reliance are formed. The plan of thus working out results in the laboratory by the aid of established facts not only serves as a drill in the manipulation and practical workings of chemical analysis, but also has the good effect of fixing the facts themselves in even the most obtuse mind.

Having spent one term of the year in the study of inorganic chemistry in the form of qualitative analysis, the student is removed to a laboratory fitted up especially for the study of physiological chemistry, where the chemistry of the body is as thoroughly studied as the amount of time will allow. Each student, supplied with the necessary apparatus and reagents, separates for himself, under the guidance of an instructor, the proximate principles from the different tissues and fluids of the body, examines and compares them one with another, studies their individual characteristics and familiarizes himself with all their properties. Commencing with albuminous matter, students are carried on in their work to the chemical examination of connective tissue, muscular tissue, flesh extracts and brain tissue. Blood and bile are likewise examined. Students also study the urine in health and disease, making microscopic examinations of deposit, learning to distinguish casts, and familiarizing themselves with all other abnormal appearances, and finally they are taught to make a complete analysis of this most important diagnostic fluid.

The value of such a course of study preliminary to medical studies cannot be overestimated. Too little attention is paid to physiological chemistry in our medical schools; not perhaps so much from a lack of appreciation of its value as from a lack of time; the more pressing need of proficiency in anatomy, surgery, and kindred subjects not allowing time for its study. In the curriculum of most medical schools we see chemistry as one of the subjects taught, but a little investigation will reveal the fact that the chemistry so taught is crowded into a term's work, and that of the most elementary character to supply the need of students not versed in the first principles of this most important science. The remedy lies not so much with the medical school, unless it be in demanding a more thorough and suitable preparation, as with the preparatory course.

Again the microscopic examination of crystals, sections of calculi, blood crystals and corpuscles, fluids, and solids in health and disease constitutes an important feature of this course and one the importance of which will be at once recognized. Besides practical work in this direction a course of lectures on the use of the microscope is delivered by Professor Brewer during the second term. Laboratory work in physiological chemistry is supplemented by recitations and lectures on the classification of the proximate principles. Instruction is also given in toxicology, a subject to which

our medical schools have time to pay but little attention. Both the mineral and alkaloid poisons are carefully studied, their principal reactions are worked out and students are taught how to apply delicate tests and to separate both the mineral poisons and alkaloids from organic mixtures. Lectures are also given on the classification of poisons, methods of preparation from the vegetable and mineral kingdoms, effects on the animal system, fatal dose, and antidotes. Arrangements are also made whereby graduate students can spend a portion of another year in quantitative analysis of urine and in supplementing their knowledge of toxicology.

During the third year the laboratory work for either four or five days in the week is devoted specially to comparative anatomy and histology. The student himself dissects specimens of a number of different animals and is required to make careful sketches and records of his work; he also examines the different animal tissues with the microscope, makes microscopical preparations and is taught the methods of anatomical and histological investigation. The object sought is not so much the storing of the mind with the minor facts of anatomy as training in the methods of the investigations by which the facts and principles of anatomy and histology have been established. Still the anatomy and histology of the higher animals is so nearly identical with that of man that all the more important features in the structure of the human body may be learned from the dissection of common animals, and so the knowledge of anatomy acquired is an important direct assistance to the student in the lecture or dissecting room of the medical school. Much stress is laid upon the acquisition of facility in the use of the microscope, not only on account of the extensive and increasing use of this instrument in medical practice, but also because it familiarizes the student with the use of delicate and accurate instruments and trains the hand and eye to their use. Instruction, by means of recitations accompanied by demonstrations and practical exercises, is given in human physiology and in the general anatomy of the higher animals, with the view of fixing the elementary principles of these subjects in the mind. The laboratory work one day each week, for two-thirds of the year, is given to the practical study of botany, in which instruction is also given by lectures. During the year instruction by lectures is given also in systematic zoology and in the laws of heredity and the principles of breeding.

A special effort is made to have the thesis, which every student

is required to prepare before graduation, based on some original investigation carried out by himself, in order to give him, if possible, that experience and self-reliance which can come only from independent work, and that discipline which is gained by the systematic arrangement and presentation of any series of facts. This effort has succeeded so well that several of the theses of the graduates in this course have been essays of permanent scientific value.

For the practical work in comparative anatomy, etc., a large and excellently lighted laboratory in the Peabody Museum furnishes ample accommodations. Professor Eaton's laboratory in North Sheffield Hall affords similar facilities for botanical work. Students are supplied with microscopes and the materials needed to prosecute their practical studies. While it is not believed that the instruction in this course thus far has materially suffered from the want of apparatus and the means of illustration necessary for the use of the students and the instructors, there is urgent need of some permanent provision for such wants, which it does not at present seem possible to meet from the available funds of the school. Such provision would become a necessity should the number of students selecting this course be much increased, for all the microscopes and much of the other apparatus of instruction used in one of the departments of the course are at present furnished at the private expense of one of the instructors, who cannot be expected to increase the amount of such expenditure.

Connecticut Agricultural Experiment Station.

At its last session, the State Legislature authorized the establishment of the Connecticut Agricultural Experiment Station, with a Board of Control consisting of eight members, one of whom, by the provisions of the act, was to be elected by the Sheffield Scientific School. In accordance with this requirement, the Governing Board chose as a member of this body Professor Wm. H. Brewer. As this School was already, and was designated by statute as the State College of Agriculture and the Mechanic Arts, there seemed to be a special propriety on its part in offering accommodations to the Station. This was accordingly done, and the offer was accepted by the Board of Control. Professor S. W. Johnson, who held the chair of Agricultural Chemistry in this School, was elected Director of the Station, and the following changes were made in the arrangement of the room in Sheffield Hall for its accommoda-

tion. The two rooms, closet and vestibule on the first floor of the east wing, lately occupied by the Mineralogical Laboratories, were rearranged and fitted up for the use of the Station, the changes and sewer connections made necessary by this involving a direct outlay for plumber, gas-fitter and carpenter bills of about $550. In addition, all the apparatus used in the laboratory, except such as has been constructed for special investigations, and those owned by the officers of the Station, has been loaned by the School thus far, without which it would have been simply impossible to carry on the analytical and other chemical work which it was required to perform. To make the accommodations as complete as possible, Room No. 1, heretofore used as a recitation room for mathematics, has been given up to the chemical department, and the instruction in mathematics has been transferred to North Sheffield Hall.

Funds.

The general prostration in the business interests of the country, and the consequent decline in the value of investments having to a certain extent affected the resources of the School, the Governing Board felt it necessary to take some decided action towards keeping the expenditures within the income. No other resource seemed to them to be open, without injuring the efficiency of the institution, than to cut down their own salaries; and accordingly at the Commencement of 1876, the permanent professors of the School gave up each $400 of his salary. The reduction went into effect the following Academic year, and is likely to be necessary for several years to come; and has, moreover, been followed by a reduction of all the running expenses of the institution to the very lowest point compatible with a successful prosecution of the studies of the various courses.

In connection with this, one important fact needs to be brought to the attention of the Legislature.

The income of the School from the fund derived from the sale of public lands, given to the State by Congress for the aid of Colleges of Agriculture and the Mechanic Arts, has this year been somewhat diminished by the circumstance that the State Treasurer has paid off certain of the State Bonds in which the fund was invested. The Commissioner of the School Fund, to whom this fund is intrusted by the State, has assumed that he has not power to re-invest without further legislative action, and it is presumed, *if necessary, such* action will be taken by the legislature, and the

deficit of interest will be made good to the institution. By the Act of Congress under which the State received this gift, it is provided that "If any portion of the fund invested, or any portion of the interest thereon, shall by any action or contingency be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished, and the annual income shall be regularly applied without diminution to the purposes mentioned." . . . . .

Gifts.

During the past year the institution has received a legacy of £1,000, the gift of the late Mrs. Susan K. Higgin, of Quarry Bank, West Derby, Liverpool. The trustees of this fund have directed that it should be added to the former generous gift of £5000 made by Mrs. Higgin in 1871, and that the income of the whole amount should be devoted to the support of the Higgin Professorship of Dynamic Engineering. The Corporation have also received in trust for the Scientific School a legacy of five hundred dollars from the estate of the late Morris Tyler.

It ought perhaps also to be added here, that the executor of the estate of the late Edward A. Mitchell, has paid to the Treasurer in advance the balance of four years subscription to the income of the School, six annual payments of two hundred and fifty dollars having been made during Mr. Mitchell's lifetime.

Through the generosity and energy of Mr. Willard N. Pratt, of the Class of 1877, the geological collection has received a very large fossil-tree stump from the mines of the Blossburg Coal Company at Arnot, Tioga Co., Penn. The specimen was exhumed about three-quarters of a mile from the entrance of the mine, and 229 feet below the surface of the mountain. It is twenty-six inches in diameter at the top and the roots spread out two or three feet on each side, making it seven to eight feet in diameter at the base. The whole weighs over two tons, and the specimen is now deposited for exhibition in the main hall of Peabody Museum. Mr. Pratt not only incurred the expense of getting out this grand specimen, but gave the matter his personal superintendence and secured its free transportation by railroad to New York City.

From the United States Department of Agriculture, a collection has been received of specimens of woods of the United States, amounting to one hundred and thirty-four (134) species, collected

under the direction of Dr. Geo. Vasey, of the Botanic Department. The specimens have been placed on exhibition in the east wing of Sheffield Hall.

From Dr. José de Saldanha, Director of the Botanic Gardens of Rio Janeiro and late Brazilian Commissioner to the Centennial Exhibition, a gift was received of Brazilian ornamental woods, fibres, rubber and other crude forest products.

A collection of starches from a considerable number of species, from the collections of several countries at the late International Exhibition, and representing a considerable number of species, has also been added to the chemical collection.

Additions to the Zoölogical Collections.

A. E. Verrill, Curator; W. H. Patton and E. B. Wilson, Assistants.

During the eighteen months, since the last report was written, all the available time of the curator has been devoted to the moving of the Zoölogical collections, which were previously stored in several different buildings, into the Peabody Museum and to overhauling, storing, and arranging them there. A large amount of time was also devoted, both by Professor S. I. Smith and the curator, to the making of the plans for the cases and other furniture of the Zoölogical department (third floor) of the museum. The summer vacation of 1876 was also devoted to moving the collections and similar work. Consequently the curator has been able to do, during all this time, very little in the way of scientific investigation, nor has he been able to keep up, to any great extent, the system of exchanges. At the present time, however, the cases in the Zoölogical department are nearly all filled and the arrangement of the collections is well advanced. In the arrangement of the collection the curator has been greatly aided by Professor S. I. Smith, who volunteered to arrange the crustacea; by Mr. Patton, who has taken charge of the insects; and by Mr. Wilson, who has assisted in arranging the shells, fishes, reptiles, &c. Professor W. D. Whitney and Mr. C. H. Merriam have also given assistance in the identification and arrangement of the birds. We are also much indebted to the skill of Mr. E. H. Hawley, who has neatly mounted many of the corals and other specimens.

During the last summer vacation, the curator, by invitation of Professor S. F. Baird, Commissioner, took charge of the dredging

operations of the U. S. Commission of Fish and Fisheries, as in previous years. Mr. E. B. Wilson acted as special assistant, during this expedition. Very extensive explorations, both with dredge and trawl, were made in Massachusetts Bay, off Salem; in the deepest parts of the Gulf of Maine; off Nova Scotia; and near Halifax. Many very interesting additions to the American fauna were made, both of fishes and invertebrates, and very extensive collections were obtained. All of the invertebrates, as in former years, were deposited here for examination and reports, and for subsequent distribution of the duplicates to other museums, when a complete series will be retained here and deposited in the museum by the curator, as a part of the special collections designed to illustrate the Zoölogy of New England.

Professor W. D. Whitney presented a very valuable collection of about 160 New England birds, beautifully mounted by himself, and deposited for several years past in the Scientific School. He has, also, recently made several additions to it,—among them a golden eagle. This collection includes a wild turkey, killed on Mt. Tom, Mass., Nov., 1847, which is believed to be the last one known to have been observed in New England. This collection will form part of the special collection of New England birds.

The curator has deposited in the museum a series of about 125 birds, collected and mounted by Mr. C. A. Houghton, at West Medway, Mass., which also now form a part of the New England collection.

Mr. Houghton has also mounted for the museum, in a very satisfactory manner, a considerable number of foreign birds, from dry skins.

The Yale Medical Institute has transferred to the museum the collection of native and foreign birds, for many years deposited in its museum by the Yale Natural History Society. There were nearly 100 native birds, mostly collected near New Haven, about 1837, and several water birds, from Stratford, Conn., collected by Rev. James H. Linsley, near the same time. These were in fair condition. The foreign birds (about 150 in number) were very badly damaged by moths, so that 112 were transferred to the Osteological department. These were from the East Indies (bought at Singapore) and presented by Mr. Peter Parker, about 1835.

The Medical Institute also presented a large collection of stuffed fishes, prepared *at Santa Cruz, W. I.*, by Dr. E. H. Bishop;

several stuffed reptiles; Gorgoniæ, corals, etc., from Bermud a lot of foreign shells.

Professor G. Brown Goode, Middletown, has sent to the curat for examination and report a very large and valuable collection Corals, Echinoderms, Hydroids, Actiniæ, etc., collected by him Bermuda. Eventually a good series of all these will be deposit in the museum by the curator. The corals at present fill special case in the west room. The Crustacea were also sent her to be studied by Professor Smith.

Professor Goode also sent a collection of fresh water Crustac from Florida and the Potomac River.

Professor James Orton, of Vassar College, sent the curator collection of Echinoderms, Crustacea and Annelids from Peru, fc determination, and presented duplicates of several interesting sp cies, among them a new and remarkable form of cestode worm now deposited in the museum.

Mr. W. H. Dall sent for examination portions of a gigant new ten-armed Cephalopod (*Ommastrephes gigantea* Dall) fro the coast of Alaska. Its body was over six feet long.

Rev. M. Harvey, sent to the curator for study a beak of anoth gigantic Cephalopod (*Architeuthis*) from Newfoundland; and al suckers from the large specimen now on exhibition in the Ne York Aquarium. He also sent a specimen of the "whalebone from the throat of the basking shark.

The Poughkeepsie Society of Natural History sent specime of a new star-fish (*Astrophyton australe* Verrill), and a rare cor (*Primnoella*), from Tasmania.

Mr. M. Mailhouse (S. S. S.) and Mr. R. J. Gibson (S. S. S. gave specimens of *Calianassa Stimpsoni*, from New Haven.

Mr. S. F. Clark (S. S. S.) presented several fine lots of Hydroi from the vicinity of New Haven.

Mr. S. S. Blodgett sent a gar-pike from Ogdensburg, N. Y.

Mr. C. A. Logan, U. S. Cunsul to Chili, presented a fine skin o a male condor, which has since been mounted.

From the Museum of Comparative Zoölogy, we have received a valuable collection of fishes, labeled by Dr. Steindachner, and mostly collected by the Hassler Expedition. From the same museum we have received a few rare Ophiurans, in exchange.

Mr. J. F. Whiteaves, Montreal, sent a few Hydroids and Crustacea from Vancouver Island.

Mr. W. H. Dall gave a series of type specimens of Hydroids

from the collection made by him in Alaska and recently described by Mr. S. F. Clark, by whom our series was selected and labeled.

Mr. S. A. Forbes, Normal, Ill., sent a small number of fresh-water Crustacea for examination.

Mr. C. J. Monson, New Haven, gave a small lot of native reptiles.

A. E. Verrill, various insects, spiders, &c., New Haven; Annelids, Crustacea, etc., Savin Rock; eggs of ruffed grouse, near New Haven, (deposited); rare fishes (among them *Icleus uncinatus*, *Lycodes Verrillii*, *Glyptocephalus cynoglossus*, *Raia radiata*) collected by the U. S. Fish Commission, off Salem and Nova Scotia, (deposited); two squirrels, muskrat and weasel, collected by C. A. Houghton (deposited); Echinoderms from Bermuda, (deposited).

Mr. Fred. S. Smith (Y. C.) presented many lernean parasites on the bream (*Pomotis*) from New Haven.

Mr. Arthur Baldwin, New Haven, presented a collection of birds' eggs.

Mr. Horace Bowman and Mr. J. Rice, each gave a bill-fish (*Belone*) from New Haven.

Mr. Elmore Smith presented a pipe-fish, from New Haven.

Mr. Geo. C. Grooms gave a fish (*Argyriosis vomer*), rare in our waters, from off Madison, Conn.

Mr. Edw. T. Owen, Hartford, has given a collection of insects from China, and also interesting specimens from Hartford, &c.

Mr. E. J. Lake presented a large lot of insects from Illinois and Connecticut.

Small collections of insects have been received from W. H. Patton, S. W. Williston, C. H. Merriam, G. E. and A. H. Verrill, E. B. Barber, Prof. S. I. Smith, Prof. W. H. Brewer, W. A. Silliman, Mrs. E. C. Bradley, A. Daggett, Jr., O. Harger, W. Hamilton, E. Crisand, Mr. Morton, Prof. D. C. Eaton, T. A. Bostwick, J. M. Bishop, F. S. Smith, A. Van Name, T. S. Gold, and others.

Mr. H. H. Curtis (S. S. S.) presented some interesting gorgoniæ, echinoderms, and shells from Nassau, N. P.

Mr. W. E. Gard (S. S. S.) presented a collection of shells from S. Africa.

Mr. C. H. Merriam (S. S. S.) gave in exchange, specimens of rare native birds; and of *Asterias littoralis*, from Eastport, Me., with the young attached around the mouth.

Mr. L. C. Bragg (S. S. S.) presented a large collection of parasitic worms (*Ascaris and Echinorhynchus*) from the hog, and also *fœtal pigs*.

Mr. C. K. Mixter (S. S. S.) gave a starfish, *Asterias Forbesii*, with two madreporic plates and six rays, from New Haven.

Mr. F. J. Martin (S. S. S.) gave, in exchange, a file fish, from New Haven.

Mr. E. B. Wilson (S. S. S.) presented specimens of crustacea, fishes and insects.

From the Boston Society of Natural History we have received, in exchange, large and fine specimens of *Primnoa reseda* and *Paragorgia arborea* from the Grand Banks, and a collection of sponges, identified by Prof. A. Hyatt, who has also returned a portion of our collection sent to him for study.

From the U. S. Commission of Fish and Fisheries we have received several lots of invertebrates, collected by V. N. Edwards, at Wood's Hole, Mass. Among these there is a fine *Octopus*, new to New England waters, and also a species of *Scyllæa* (allied to *S. Grayi* Ad.), entirely unknown previously on the American coast (deposited).

From the Smithsonian Institution we have received, for examination, a lot of invertebrates from Florida, collected by Prof. S. F. Baird; also several lots from various localities.

Mrs. M. Kimball presented a living "horned toad" from Texas.

Mr. E. T. Green, Oakland, Cal., presented a living "Tarantula" in its tubular nest. After the death of the parent, 95 living young were taken from the nest.

Mr. H. H. McIntyre gave a large skate's egg and a lot of hydroids from St. Paul's Island, Alaska.

Mr. N. T. Bacon (S. S. S.) gave a puffing adder, New Haven.

Miss Carrie Atwater, New Haven, presented a living sharp-shinned hawk.

Miss Helen Lennebacker, Santa Barbara, Cal., sent a very interesting collection of ascidians, hydroids, &c.

Mr. Hunter Nicholson, Knoxville, Tenn., sent phrygania larvæ, which by making crescent-shaped webs on ledges in streams, retain pebbles and cause them to wear small pits in the rock.

Dr. D. B. Delavan, New York, deposited a large specimen of coal (*Dendrophyllia nigrescens*) from the Hawaian Islands. It has been bleached, mended and mounted since it was received.

Mr. John Tiernan presented a rare actinia (*Paractis rapiformis*) from the mouth of the Quinnipiac River, Fair Haven.

Mr. J. Matthew Jones, Halifax, presented a series of dry *echinoderms, from* Bermuda; also various invertebrates from Nova *Scotia; mammals* from Halifax, &c.

Provincial Museum, Halifax, sent for examination fragments of sponges and corals, and suckers of a new cuttle-fish (*Architeuthis*) from Cape Sable, N. S.

Mr. G. B. Grinnell gave four rare birds from Milford, Conn.

Mr. R. T. Morris presented an "old squaw" and least bittern, from New Haven.

Prof. S. Wells Williams gave an emerald bird of paradise, and king bird of paradise (*Paradisea regia*) from the East Indies.

Mr. A. H. Thompson presented a little auk (*Mergulus alle*) from near New Haven, (prepared by G. B. Grinnell).

Prof. C. F. Hartt, Geol. Survey of Brazil, sent to the curator, for identification, an interesting lot of gorgoniæ and corals from Brazil, (deposited).

Another lot, sent for identification, was received from the Bermuda Centennial Commission.

Owing to the urgent character and great amount of museum work that needed to be done at once, only a few collections have been sent away in exchange during the year, and only a part of those sent here for examination have been returned, much to our regret. Among the collections sent away are the following:

Two collections of Crustacea and two of Echinoderms sent to the Museum of Comparative Zoölogy, in exchange.

A collection of Bryozoa presented to Mr. C. F. Cox, together with a lot of specimens, determined by the Curator and returned.

A collection of Bryozoa determined by the Curator and returned to Prof. A. Hyatt.

Collections of Crustacea, Mollusca, sponges and star-fishes sent to Prof. S. F. Baird for the Centennial Exhibition.

A collection of Crustacea from Bermuda, sent by G. Brown Goode, has been determined by Prof. S. I. Smith and returned.

A collection of Crustacea, labelled by Prof. S. I. Smith, and one of Hydroids, determined by Mr. S. F. Clark, both from Vancouver Island, have been returned to Mr. J. F. Whiteaves.

Several collections of fresh-water Crustacea, insects, &c., have been determined by Professor Smith and returned to different parties.

Portions of the *Architeuthis dux* loaned to the Curator by the Museum of Comparative Zoölogy, have been returned; and several star-fishes (among them *Asterias stellionura*) from off Nova Scotia, have been sent in exchange.

The *jaws of Architeuthis princeps* V., loaned to the curator for

description and figures, have been returned to the Peabod Academy of Science, Salem.

Collections of sponges have been sent to Prof. A. Hyatt fc study, and part of them have been returned.

The crustacea belonging to the family Alpheidæ were sent to Mi Kingsley, Salem, Mass., for study, and have been returned by hin

A collection of Annelids was given to Prof. H. G. Webste Union College, in exchange.

A collection of corals and echinoderms was sent to Wesleya University, in exchange.

The entire collection of North American spiders has been sen to Mr. J. H. Emerton, Salem, Mass., for study, and part of ther have been labelled and returned.

A collection of Crustacea, Pycnogonids, Echinoderms, Bryozo and Sponges has been sent to Rev. A. M. Norman, in exchange.

Series of marine invertebrates, from the collection of the U. S Fish Commission, have been given to the Peabody Academy c Natural Science, Salem, Mass., and to the Provincial Museum c Nova Scotia; also a few specimens to the New York Aquarium and to Mr. W. H. Dall.

A small collection of amphibians and specimens of *Malac bdella* was presented to Prof. Carl Semper.

A large stuffed head of the elk, formerly presented by Pro O. C. Marsh, was returned to him by special request.

A small collection of bird skins was given to Mr. C. H. Me riam, in exchange.

A number of books, chiefly serials, belonging to this departmen have been deposited in the College Library.

Contributions to the Study of the New Haven Region.

To the courtesy of Mr. Bache, of the United States Coast Sa vey, the Governing Board are under renewed obligations for report of the progress of the work of surveying the New Hav region. Operations, it must be stated, have been largely circu scribed in consequence of the lowness of appropriation by whi all government works have been affected; and as, moreover, la instructions from Washington prevent any further extension of t work in this region, this report will be a final one.

"The season's field-work, given in the Annual Report f *1875–76,*" says Mr. Bache, in his communication to the Boar "*was followed by* office work, in which Mr. Andrews, graduate

the School, was employed; and temporarily, also, Mr. Bogart, a graduate, who was then discharged for want of means to keep him. Mr. Gillette, undergraduate, also assisted for a short time in the draughting.

"Early in the spring of 1877, Messrs. Gillette and Bogart, alternately, ran contouring lines over the country around Lake Saltonstall, of which the horizontal survey had been made during the preceding season; and Mr. Andrews determined a few points by triangulation, to meet the season's prospective topography.

"At the beginning of July, a small additional appropriation became available for work, but not more than upon the most moderate basis. Consequently we were not able to employ more than two or three persons during the season, making a proportional reserve for office work. Mr. Bogart took charge of a plane-table party, assisted by Mr. Gillette, and by Mr. C. McKibben Craig, graduate of the School, which party first filled in some unfinished spots in the Woodbridge Valley, and then surveyed the country northwest of Centreville, including the part of West Rock Ridge near and at the gorge that lies under the spur known as High Rock, in which crosses the only communicating road over the ridge between the New Haven Plain and Woodbridge Valley.

"The details of this triangulation and topography are as follows:—The triangulation added five points, situated on high hills in Hamden. The Giant's Head is the knob on the western part of Mt. Carmel. Of these points, only Howard, No. 2, can be occupied as a station, the rest being points in trees, marked with flags. Howard, No. 2, is marked with a large stake and a pile of stones.

Geographical Positions.

	Latitude.	Longitude.
Long Hill,	41° 24′ 06″.245	72° 53′ 09″.702
Giant's Head,	41 25 33.765	72 53 59.207
York Hill,	41 24 30.003	72 55 09.943
Howard, No. 2,	41 24 49.086	72 52 33.172
Brethren,	41 24 51.120	72 55 48.847

Distances between the Points.

	Metres.
Long Hill to West Rock North,	6,744.2
Long Hill to Rabbit Rock,	7,219.6
Giant's Head to West Rock North,	7,137.3
Giant's Head to Rabbit Rock,	10,153.7
York Hill to West Rock North,	4,608.3
York Hill to Rabbit Rock,	9,246.8
Howard, No. 2, to Rabbit Rock,	8,223.5
Howard, No. 2, to High Rock,	5,092.7
Brethren to Rabbit Rock,	10,314.4
Brethren to Howard, No. 2,	4,544.3

Topography.

"In the country around Lake Saltonstall, there was executed the amount of ten and six-tenths (10.6) square miles of contouring with the water-level. In Woodbridge Valley, and in Hamden and Bethany, in the localities before specified, the work executed was as follows:

Square miles (Woodbridge Valley),	0.10
Square miles (Hamden and Bethany),	4.96
Length of main roads,	10.75
Length of secondary roads,	12.00
Length of brooks,	13.90

"The maps of the whole area surveyed since we came here (eight sheets), fully completed in drawing, will all be sent to the Coast Survey office before the end of December."

Public Lectures.

The eleventh annual course of lectures to mechanics and others was given during the past year in the lecture-room in North Sheffield Hall. The lecturers and their subjects are indicated in the annexed programme.

I.	Thurs., Feb. 8.	Forests and Forest Products,	Wm. H. Brewer.
II.	Mon., " 12.	Mosses,	D. C. Eaton.
III.	Thurs., " 15.	Forests and Forestry,	Wm. H. Brewer.
IV.	Mon., " 19.	Graphics,	F. R. Honey.
V.	Thurs., " 22.	Tea.	D. C. Eaton.
VI.	Mon., " 26.	Our Red Sandstone,	G. W. Hawes.
VII.	Thurs., March 1.	The Usury Laws,	F. A. Walker.
VIII.	Mon., " 5.	Methods of preserving Timber from Decay,	W. H. Brewer.
IX.	Thurs., " 8.	Fermentation and Putrefaction.	S. W. Johnson.
X.	Mon., " 12.	The relations of Sound and Sense,	Mark Bailey.
XI.	Thurs., " 15.	Sanitary Engineering,	W. P. Trowbridge.
XII.	Mon., " 19.	Some of the Phenomena of Heat,	J. J. Skinner.
XIII.	Thurs., " 22.	The Zoological Department of the Peabody Museum,	A. E. Verrill.

In addition to these, an interesting and valuable course of lectures on Military Science was delivered to members of the Senior Class and others, by officers from the U. S. Engineering School, at Willet's Point, as a part of the instruction in the school during the year 1876. The order and subjects of the lectures were as follows:

I.	May 2.	War Material,	Maj. King.
II.	" 5.	Strategy and Grand Tactics,	Capt. Livermore.
III.	" 9.	Permanent Fortifications,	Lieut. Bass.
IV.	" *11.*	*Torpedoes,*	General Abbott.
V.	" *16.*	*Field Fortifications,*	Lieut. Rossell.
VI.	" *18.*	*Passage of Rivers,* and Military Bridges,	Lieut. Symonds.

ANNIVERSARIES.

Two anniversary exercises have been held since the publication of the last Annual Report. The first of these was on the evening of Tuesday, June 27, 1876. Nine theses were selected for public reading.

The candidates for degrees, with the subject of their graduating theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

BACHELORS OF PHILOSOPHY. (49)

DAVID ROOT ALDEN (Civil Engineering), *Westville.* A Review of the Risdon Turbine.

HALSEY WARREN ALLEN (Civil Engineering), *Jersey City, N. J.* Five Designs of a Dam to Resist a Thirty-foot Head of Water.

EVELYN MARCELON ANDREWS (Civil Engineering), *Norwich.* On Compressed Air as a Motive Power.

*CHARLES EBEN BACON (Civil Engineering), *Middletown.* On Improved Methods of Driving Piles.

CHARLES LORING BRACE (Civil Engineering), *Hastings, N. Y.* On the New Haven Water Works.

FRANK ELWOOD BROWN (Civil Engineering), *West Haven.* On the Application of Steam Power to Canal Navigation.

WILLIAM MCCULLOH BROWN (Chemistry), *Brookline, Mass.* On the Fossil Iron Ores of West Virginia.

WILL C. BROWNING (Chemistry), *Norwich.* On the Hydraulic Cement of Woodbridge, Ct.

WALTER CLEVELAND BUTLER (Civil Engineering), *New Haven.* A Review of the Stone Bridge over Mill River at New Haven.

LLOYD JOSEPH CASWELL (Civil Engineering), *Norwich.* An Investigation of the Pumping Apparatus at Whitneyville, Conn.

JOHN HENRY CHAPMAN (Civil Engineering), *New York City.* A Partial Discussion of the International Art Gallery at Philadelphia.

SIDNEY WILLIAMS CLARK (Select), *Hartford.* On the Culture and Manufacture of Cotton in the United States.

JOHN MOFFAT CUNNINGHAM (Civil Engineering), *Poughkeepsie, N. Y.* On the Blake Stone Crusher.

*FREDERICK PERKINS DEWEY (Chemistry), *West Haven.* On the Separation of Tin and Antimony.

*GEORGE CORNWALL DUNHAM (Civil Engineering), *Southington.* A Review of the New Quinnipiac Bridge at Fair Haven.

*STANLEY FORBES (Civil Engineering), *San Francisco, Cal.* On Tidal Motive Power.

EDWARD LIVINGSTON FORD (Civil Engineering), *Buffalo, N. Y.* On the International Bridge at Buffalo, N. Y.

PORTER DWIGHT FORD (Civil Engineering), *Washington.* A Review of the Dra Span in the Bridge at Providence, R. I.

EDWARD JASPER FRANCKE (Chemistry), *New York City.* On the Composition a Method of Analysis of Raw Sugars.

*ROBERT JACKSON GIBSON (Medical), *New Haven.* On the Anatomy of *Callianas Stimpsoni.*

JACK HAYS HAMMOND (Select), *San Francisco, Cal.* On the Indian Question.

*JAMES LAWRENCE HOUGHTELING (Select), *Chicago, Ill.* On the Climatic Effec of Forests.

RANDELL HUNT (Civil Engineering), *New Orleans, La.* On the Improvements South Pass, Mouth of the Mississippi.

EDWARD HINE JOHNSON (Select), *Brooklyn, N. Y.* On the New England Co federation of 1643.

JAMES TEWKSBURY LAW (Select), *Tarrytown, N. Y.* On the History of Dire Taxation in the United States.

THOMAS HOWARD LINSLEY (Civil Engineering), *West Meriden.* On the Applicatio of City Water Power to Small Motors.

JOHN FRANCIS LUBY (Medical), *New Haven.* On the External Anatomy of th Pawn (*Palæmonetes Vulgaris*).

CALVIN MORGAN MCCLUNG, B.A., East Tennessee University, (Chemistry), *Kno ville, Tenn.* On Schorlomite from Magnet Cove, Arkansas.

ALBERT SUTTON MACGREGOR (Select), *New York City.* On the Factory Laws England.

MAX MAILHOUSE (Medical), *New Haven.* On the Anatomy of the Yellow Per (*Perca Favescens*).

HOWARD MEYER (Select), *New York City.* On India Rubber.

FREDERICK PLUMB MILES (Chemistry), *Salisbury.* On the Causes of Differe Qualities of Cast Iron.

HIRAM ALLEN MILLER (Civil Engineering), *New Haven.* Discussion of the Curv whose Equation is $\sin^4 x + \sin^4 y = a \sin x \sin y \sin \frac{x+y}{2}$.

WILLIAM MAYO NEWHALL (Select), *San Francisco, Cal.* On Mormonism in t Past, the Present and the Future.

*JOHN ROBERT PADDOCK (Natural History), *Cheshire.* On the Anatomy of t Green Frog (*Rana Clamitans*).

WILLIAM BEACH PALMER (Civil Engineering), *Bridgeport.* A Review of the Ir Light House, South West Pass, La.

*EDWARD LARNED RYERSON (Select), *Chicago, Ill.* On the Post Office of t United States.

WILLIAM BABCOCK SAWYER (Select), *Buffalo, N. Y.* On Fairy Mythology as Illu trated in the Elizabethan Writers.

CHARLES DAVID SEEBERGER (Select), *Chicago, Ill.* On the United States Ban of 1816.

ANDREW GILBERT SHEAK (Select), *Binghamton, N. Y.* On Usury.

GORDON EDWARD SHERMAN (Select), *Morristown, N. J.* On Cuneiform Inscri tions; their Discovery, Interpretation, and Historical Value.

*THOMAS EWING SHERMAN, B.A., Georgetown College (Select), *St. Louis, Mo.* Chemical Evidence in Cases of Arsenic Poisoning.

GEORGE WATSON SMITH (Select), *Chicago, Ill.* On Trades Unions and Strikes.

FRANCIS AUGUSTUS TERRY (Chemistry), *Lyme.* On the Origin of Magnetic Sands in the Vicinity of New Haven.

FREDERICK WILLIAM VANDERBILT (Select), *New York City.* On the Poor Laws of England.

CHARLES WILLIAM VAN VLECK (Select), *Cincinnati, O.* On the Union Pacific Railroad.

CHARLES ALEXANDER WATSON (Select), *Hartford.* On Direct Taxation in the Fiscal History of the United States.

FREDERICK WOOD (Civil Engineering), *Norwalk.* On Pile Foundations.

THOMAS YEATMAN (Select), *New Haven.* On the Indian Policy of the United States Government.

PRIZES.

The following prizes announced at the anniversary:

CLASS OF 1876.

For *excellence in English Literature*, the prize awarded to THOMAS E. SHERMAN, *St. Louis, Mo.*

For *excellence in German*, the prize awarded to MAX MAILHOUSE, *New Haven.*

For *excellence in French*, the prize awarded to FREDERICK P. DEWEY, *West Haven.*

For *excellence in Civil Engineering*, the prize awarded to PORTER D. FORD, *Washington.*

CLASS OF 1877.

For *excellence in the Mathematics of Junior Year*, the prize awarded to JOSEPH P. IDDINGS, *Orange, N. J.*, with honorable mention of JOHN E. BUDDINGTON, *Huntington.*

For *excellence in Chemistry*, the prize awarded to HORACE L. WELLS, *New Britain.*

For *excellence in Mineralogy*, the prize awarded to SAMUEL L. PENFIELD, *Catskill, N. Y.*

CLASS OF 1878.

For *excellence in all the Studies of Freshman Year*, the prize awarded to LEVI A. ELIEL, *Chicago, Ill.*, with honorable mention of JOHN P. BARTLETT, *New Britain.*

For *excellence in German*, the prize awarded to RALPH A. HARMAN, *Cleveland, O.*

For *excellence in Mathematics*, the prize awarded to WALTER L. COWLES, *Wallingford.*

For *excellence in Physics*, the prize awarded to CHARLES S. CHURCHILL, *New Haven.*

For *excellence in Mechanical Drawing*, the prize awarded to JOHN L. BLACKMORE, *City of Mexico, Mexico.*

The anniversary exercises for the Class of 1877 were held on Tuesday, June 26th, 1877, at which time ten theses, denoted in the following schedule by an asterisk, were publicly read. The following are the names of the candidates for degrees, with the subjects of their theses.

CIVIL ENGINEERS. (3)

CHARLES JAMES MORSE, Ph.B., Engineer Massilon Iron Bridge Co., *Massilon, O* Design of a Wrought Iron Truss Bridge of 210 feet span, built by the Company across Mahonning river at Warren, Ohio.

WILLIAM LUCIEN SCAIFE, Ph.B., *Pittsburgh, Pa.* Improvement of the Upper Seine and Yonne Rivers, France.

DYNAMIC ENGINEERS. (2)

CHARLES HOWARD FITCH, Ph.B., *New Haven.* Design of a Machine for Cutting Twist Drills.

CHARLES HILDEBRAND, Ph.B., *New Haven.* Design of an Iron Steam Ship of Three Thousand Five Hundred Tons Displacement.

BACHELORS OF PHILOSOPHY. (52)

WILLIAM WHITTLESEY ABBOTT (Select), *Yarmouth, Me.* On the Rocky Mountains in Colorado.

WILLIAM HENRY BACKUS (Civil Engineering), *Cleveland, O.* On the Ashtabula Bridge and the Causes of its Failure.

GEORGE HENRY BARTLETT (Civil Engineering). *North Guilford.* On the Roof Truss of the Car Shop of the N. Y., N. H., & H. R. R.

*MORRIS BURKE BELKNAP (Dynamic Engineering), *Louisville, Ky.* On Sanitary Drainage.

BERNARD BERENS (Select), *Philadelphia, Pa.* On the Strikes in the Mining Districts of Pennsylvania.

ARTHUR LEWIS BETTS (Civil Engineering), *Norwalk.* On the Iron Bowstring Girder Bridge at Westville.

FRANK LEWIS BIDWELL (Civil Engineering). *Kansas City, Mo.* On the Kansas City Bridge.

*JAMES HENRY BREWSTER (Select), *New Haven.* On the Occupation and Cultivation of the Soil in Village Communities.

*JOHN EDWARDS BUDDINGTON (Civil Engineering), *Huntington.* Review of the Pivot Bridge over the Housatonic, on the N. Y., N. H., & H. R. R.

FRANK CALDWELL (Medical), *Carthage, O.* On the Anatomy of the American Medicinal Leech (*Macrobdella decora*)

*JOSEPH GILBERT CALHOUN (Select), *Hartford.* On the Arthurian Legend and its History in English Literature.

FREDERICK LEONARD COWLES (Select), *New Haven.* On the Growth and Progress of Agriculture in the United States.

HENRY HOLBROOK CURTIS (Medical), *New York City.* On the Encephalon of the Shad (*Alosa sapidissima*).

JUDSON AMOS DOOLITTLE (Civil Engineering), *Cheshire.* On the Shore Line R. R. Bridge over the Quinnipiac River at Fair Haven.

*WALLACE BRUCE FENN (Civil Engineering), *New Haven.* On the South-West Ledge Light House.

BURR KELLOGG FIELD (Civil Engineering), *Germantown, Pa.* On the Lake Roland Dam, Baltimore Co., Md.

JOACHIM JOHN FRANCKE (Select), *New York City.* On Turkey and the Turks.

WILLIAM EDGAR GARD (Chemistry), *New York City.* On the Combination of *Carbon with Nickel.*

JOHN ELISHA MORPETH HALL (Select), *Brooklyn, N. Y.* On Coinage.

WILLIAM STANLEY HINE (Civil Engineering), *Bridgeport.* On the Springfield Gas Machine.

WALTER HOLCOMB (Civil Engineering), *New Hartford.* The Law and its Application in regard to unsafe Engineering Constructions.

HORACE COBB HOWARD (Select), *Townshend, Vt.* On Serfdom in Russia.

*JOSEPH PAXSON IDDINGS (Civil Engineering), *Orange, N. J.* Review of the Pumping Engine, Pumps, and Shaft at the Ueberroth Mine, Friedensville, Pa.

CHARLES MAPLES JARVIS (Civil Engineering), *Binghamton, N. Y.* On the Improvement of New Haven Harbor.

LAWRENCE KNEELAND (Civil Engineering), *Brooklyn, N. Y.* On the Royal Gunpowder Factory at Waltham Abbey, England.

ELIJAH THIEN FOH LAISON (Civil Engineering), *Shanghai China.* On Underground Surveying, applied to the Cheshire Barytes Mine.

FRANK COOPER LAWRANCE (Dynamic Engineering), *New York City.* On Steel, its Manufacture and its Application to Structures hitherto made of Iron.

ALTON WINSLOW LEIGHTON (Civil Engineering), *New Haven.* On Railway Coaches.

CHARLES JAMES LUCK (Civil Engineering), *Rouse's Point, N. Y.* On Fort Montgomery at Rouse's Point, N. Y.

FERRIER JOHN MARTIN (Select), *Orange, N. J.* On Carpet Manufacture.

CHARLES KNOX MIXTER (Select), *Rock Island, Ia.* On Woman's Wages.

JAMES BLAIR MURRAY (Select), *Norwich.* On the Jeffersonian Embargo.

SAMUEL LEWIS PENFIELD (Chemistry), *Catskill, N. Y.* On Basic Sulphates of Copper.

WILLARD NOURSE PRATT (Select), *Elmira, N. Y.* On the History of Direct Taxation in the United States.

FRANCIS RAWLINSON READ (Civil Engineering), *Hartford.* On Explosives as Applied to Engineering.

LUCIUS WATERMAN ROBINSON (Civil Engineering), *Fair Haven.* On a Proposed Plan for a Wrought Iron Pin Bridge at Middletown Avenue, New Haven.

THOMAS FITCH ROWLAND (Dynamic Engineering), *Greenpoint, N. Y.* On the Application of Steam for the Propulsion of War Vessels of the United States Navy.

JAMES ALVIN SCOTT (Civil Engineering), *Naugatuck.* On the West River Bridge.

*WILLIAM THOMPSON SEDGWICK (Medical), *Farmington.* On the Functions of the Appendages, and the Anatomy of the Larger Fiddler Crab (*Gelasimus minax*).

CHARLES DWIGHT SMITH (Dynamic Engineering), *Plantsville.* On Drop Forgings.

GEORGE SMITH (Civil Engineering), *New Haven.* On the Process and Applications of the Sand Blast.

WALTER SNOWDON SMITH (Select), *Cincinnati, O.* On Trades Unions.

*HENRY LING TAYLOR (Medical), *New York City.* On the Alimentary Canal of the Larval Bull-frog (*Rana Catesbiana*).

ARTHUR JOHN TENNEY (Dynamic Engineering), *New Haven.* On the Drainage of London.

ALLEN MASON THOMAS (Medical), *Wickford, R. I.* On the Circulatory System of the Common Flounder.

WILLIAM GILMAN THOMPSON (Medical), *New York City.* On the Fœtal Circulatory System of the Domestic Pig.

JOHN ARREL WEEKES (Select), *New York City.* On the Paper Money of the American Revolution.

*Horace Lemuel Wells (Chemistry), *New Britain.* Determination of Titanic Acid in Iron Ores containing Phosphoric Acid.

James Harold Wickersham (Select), *Lancaster, Pa.* On the Advantages derived by Society from the Use of Money.

Albert Daniel Wilson (Civil Engineering), *Newburg, N. Y.* Comparison of the Cost of a Bridge over the Hudson River at Poughkeepsie, N. Y., and that of a Tunnel under the River.

George Leverett Wilson (Civil Engineering), *West Killingly.* On the Low Service Pumping Engine of the Providence Water Works.

*Edwin Young (Select), *Honesdale, Pa.* On the Application of the Principle of Natural Selection to the Origin and Development of Nations.

Prizes.

The following prizes were announced at this anniversary:

Class of 1877.

For excellence in Geology and Zoology, the Belknap prize awarded to Henry L. Taylor, *New York City.*

For excellence in English Literature, the prize divided between Joseph G. Calhoun, *Hartford*, and Horace C. Howard. *Townshend, Vt.*

For excellence in German, the prize awarded to Henry L. Taylor, *New York City.*

For excellence in French, the prize awarded to Henry L. Taylor, *New York City.*

For excellence in Civil Engineering, the prize awarded to Joseph P. Iddings, *Orange, N. J.*

Class of 1878.

For excellence in the Mathematics of Junior Year, the prize awarded to Walter L. Cowles, *Wallingford.*

For excellence in Chemistry, the prize divided between Edward E. Brewster, *West Cornwall*, and Edward H. Smith, *Brooklyn, N. Y.*

For excellence in Mineralogy, the prize awarded to Edward E. Brewster, *West Cornwall.*

Class of 1879.

For excellence in all the Studies of Freshman Year, the prize divided between Lindon Bates, *Chicago, Ill.*, and George A. Saunders, *Newport, R. I.*

For excellence in German, the prize awarded to William J. Comstock, *Toledo, O.*

For excellence in Mathematics, the prize divided between Lindon Bates, *Chicago, Ill.*, and George A. Saunders, *Newport, R. I.*

For excellence in Physics, the prize divided between George A. Saunders, *Newport, R. I.*, and Herbert E. Smith, *Hartford*, with honorable mention of Albert L. Webster, *Bethlehem, Pa.*

For excellence in Mechanical Drawing, the prize divided between Roger C. Ballard, *Louisville, Ky.*, and Samuel E. Barney, *New Haven*, with honorable mention of Lindon Bates, *Chicago, Ill.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1877-78.

CALENDAR.

1877.		
13 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.
1878.		**Winter Vacation of three weeks.**
10 Jan.	Thursday,	Second Term begins.
17 April,	Wednesday,	Spring Recess begins.
24 April,	Wednesday,	Spring Recess ends.
25 June,	Tuesday,	Meeting of Appointing Board.
25 June,	Tuesday,	Anniversary.
27 June,	Thursday,	Commencement.
28 June,	Friday,	Examination for Admission.
29 June,	Saturday,	
		Summer Vacation of eleven weeks.
10, 11 Sept.	Tues., Wedn.,	Examination for Admission.
12 Sept.	Thursday,	First Term begins.
19 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.
P. M.	Peabody Museum.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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REV. NOAH PORTER, D.D., LL.D.

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ARRANGED IN THE ORDER OF THEIR GRADUATION.

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OTHNIEL C. MARSH,
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OSCAR D. ALLEN,
Analytical Chemistry and Metallurgy. (20 S. H.) 189 Temple st.

ADDISON E. VERRILL,
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SIDNEY I. SMITH,
Comparative Anatomy. (42 N. S. H.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 25 Eld st.

A. JAY DU BOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

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ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 27 Eld st.

MARK BAILEY,
Elocution. (150 F.) 185 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY.
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

OSCAR HARGER,
Palæontology. (9 P. M.) 14 University pl.

JOSEPH J. SKINNER,
Mathematics. 55 N. S. H.

MANSFIELD MERRIMAN,
Civil Engineering. (16 S. H.) 7 Warren st.

AUGUST H. EDGREN,
French. 73 York st.

GEORGE W. HAWES,
Mineralogy. (2 P. M.) 14 S. H.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (13 S. H.) 95 Humphrey st.

JOSEPH F. KLEIN,
Mechanical Drawing. (45 N. S. H.) 86 Nicoll st.

WILLIAM H. PATTON,
Zoology. 46 N. S. H.

JOSEPH P. IDDINGS,
Surveying. 119 W. D. H.

SAMUEL L. PENFIELD,
Analytical Chemistry. 14 S. H.

GRADUATE STUDENTS.

William Whittlesey Abbott, PH.B.	*New Haven*	257 Church
George Henry Bartlett, PH.B.	*North Guilford*	157 Church
Morris Burke Belknap, PH.B.	*Louisville, Ky.*	86 W. D—
Thomas Marcus Blakslee, PH.B. Madison University	*Hamilton, N. Y.*	36 Prospect
Francis Elwood Brown, PH.B.	*West Haven*	West Ha
Russell Henry Chittenden, PH.B.	*New Haven*	95 Humphre
Frederic Henry Crafts, B.A. Dartmouth College	*Uncasville*	170 Georg
Thomas Henry Dewey, LL.B.	*West Haven*	49 Churc
Judson Amos Doolittle, PH.B.	*Cheshire*	17 Wooste
Edward Livingston Ford, PH.B.	*Buffalo, N. Y.*	48 Colleg
George Bird Grinnell, B.A.	*New York City*	6 Librar
George Wesson Hawes, PH.B.	*Boston, Mass.*	14
Henry Allen Hazen, B.A. Dartmouth College	*New Haven*	169 Templ
Joseph Paxon Iddings, PH.B.	*Ora ge, N. J.*	119 W.
James Boyd Neal, B. A.	*Bloomsburg. Pa.*	6 Librar
Herbert Franklin Northrup, B.A. Middlebury College	*Shoreham, Vt.*	73 Yor
John Robert Paddock, PH.B.	*Cheshire*	Ches
William Hampton Patton, B.A.	*Waterbury*	46 N.
Samuel Lewis Penfield, PH.B.	*Catskill. N. Y.*	14
Lucius Waterman Robinson, PH.B.	*Fair Haven*	464 Chapel s
George Smith, PH.B.	*New Haven*	83 Ashmun st
Horace Lemuel Wells, PH.B.	*New Britain*	N. S. H.

GRADUATES, 23.

SENIOR CLASS.

ıy Allen	*Hartford*	116 College st.
andon Alvord	*West Winsted*	116 College st.
ıroy Bartlett	*New Britain*	116 College st.
Blackmore	*City of Mexico, Mexico*	40 Park st.
ɾerett Brewster	*West Cornwall*	123 Park st.
illiams Brown	*Yonkers, N. Y.*	61 Grove st.
·ler Browne	*Lisbon*	155 Church st.
ɾber Burrows	*Decatur, Ill.*	25 College st.
lliam Canfield	*Hartford*	81 Wall st.
liams Chapin	*Springfield, Mass.*	36 Elm st.
·over Chapin	*Somers*	104 Grove st.
ıuel Churchill	*New Haven*	257 Franklin st.
sley Cowles	*Wallingford*	153 Crown st.
ſames Emery	*Bangor, Me.*	35 Howe st.
ırwell	*Chicago, Ill.*	36 Elm st.
t Doolittle Fowler	*North Haven*	133 College st.
ccheus Gordon	*Brookville, Pa.*	8 Lock st.
anger	*Chicago, Ill.*	450 Chapel st.
assall Greene	*Norwich*	450 Chapel st.
·ges Guthrie	*Buffalo, N. Y.*	464 Chapel st.
ıstus Harman	*Cleveland, O.*	36 Elm st.
man Hart	*New Haven*	82 Trumbull st.
wart Hegeman	*Brooklyn, N. Y.*	61 Grove st.
tts Hillhouse	*New Haven*	3 Hillhouse av.
ıuel Hulbert	*West Winsted*	31 Prospect st.
ıstin Jacks	*Helena, Ark.*	87 Olive st.
with Jillson	*Whitehall, N. Y.*	61 Grove st.
ırless LeBourgeois	*St. James Parish, La.*	36 Elm st.
·hard Lee	*Kenosha, Wisc.*	115 Park st.
bb Mason	*Orange, N. J.*	86 W. D. H.
mes Perry Moore	*New Britain*	97 William st.
ıer Moorhead	*Pittsburgh, Pa.*	61 Grove st.
ıry Potts	*Pittstown, N. J.*	61 Grove st.
wnsend Reed	*Albany, N. Y.*	257 Church st.
eodore Richmond	*Johnsonville, N. Y.*	61 Grove st.
lbourn Roberts	*New Haven*	8 Brown st.
ɔrbach	*New York City*	104 Grove st.
ıbbard Russell	*New Haven*	19 Wooster pl.
·rndon Smith	*Brooklyn, N. Y.*	36 Elm st.
ıain Vliet	*Cleveland, O.*	193 Temple st.
ngs Ward	*Marseilles, Ill.*	523 Chapel st.
·echer Wilson	*Geneva, Ill.*	57 N. S. H.
ıa Winslow	*Washington, D. C.*	36 Elm st.

SENIORS, 43.

JUNIOR CLASS.

Frederick Innis Allen	*Auburn, N. Y.*	33 P
Harry Washington Asher	*New Haven*	6
William Montgomery Atwater	*New Haven*	
Charles Ketchum Averill	*Bridgeport*	12
Charles Rufus Ayres	*Woodmont*	
Nathaniel Terry Bacon	*New Haven*	196
Samuel Eben Barney	*New Haven*	11
George Frederick Hunter Bartlett	*Buffalo, N. Y.*	6
Lindon Bates	*Chicago, Ill.*	
Joseph Bidleman Bissell	*Lakeville*	11
Malcom Booth	*South Kingston, R. I.*	17 W
Harry Osborn Carrington	*New Haven*	527
Frederick Burr Clemmons	*New Haven*	162 I
William James Comstock	*Toledo, O.*	37 (
Albert William Congdon	*Brooklyn, N. Y.*	4
John Howard Cromwell	*Cranford, N. J.*	122 (
Charles Thompson Dodd	*West Meriden*	134 (
Arthur Dodge	*Stamford*	134 (
George Clarence Egan	*Chicago, Ill.*	:
Emerson Young Foote	*New Haven*	11
Norman Norton Fowler	*Agawam, Mass.*	141 I
John Currier Gallagher	*New Haven*	2
Jonathan Godfrey	*Southport*	134 (
Frank Hanson Harrison	*Indianapolis, Ind.*	15
Gerald Waldo Hart	*New Britain*	33 P
Harry Dudley Hibbard	*Woodside, N. Y.*	464
Frank Hillhouse	*New Haven*	3 Hil
Charles DeVilliers Hoard	*Chicago, Ill.*	416
Charles Perry Hull	*Lebanon*	12
John Jewett	*Brooklyn, N. Y.*	55 Tr
Willard Drake Johnson	*Washington, D. C.*	
Frederick Augustus Jones	*Newark, N. J.*	163 '
Alfred Dennis Lewis	*Bridgeport*	134 (
George Walker Meeker	*Chicago, Ill.*	55 Tr
Kakichi Mitsikuri	*Tokio, Japan*	523
John Moorhead	*Pittsburgh, Pa.*	1(
Edward Delevan Nelson	*New York City*	55 Tr
Walter Nordhoff	*Alpine, N. J.*	14
Frederick Wallace Paramore	*St. Louis, Mo.*	:
Robert Wilson Patrick	*Omaha, Nebr.*	531
William Eckhardt Raht	*Cleveland, Tenn.*	87 (
Edward Vilette Reynolds	*Chicago, Ill.*	1(
Edward Rupert Sargent	*New Haven*	132 W
George Augustus Saunders	*Newport, R. I.*	157 E
William Seth Silsby	*Seneca Falls, N. Y.*	:

Rufus Henry Skeel	*Newburgh, N. Y.*	31 Prospect st.
Herbert Eugene Smith	*Hartford*	141 Bradley st.
Thaddeus Henry Spencer	*Suffield*	141 Bradley st.
Isaiah Kidder Stetson	*Bangor, Me.*	62 W. D. H.
Daniel Eddie Stone	*Cleveland, O.*	61 Grove st.
Arthur Stoddard Van Voorhis	*New York City*	94 Grove st.
John Thomas Waring	*Yonkers, N. Y.*	61 Grove st.
Albert Lowery Webster	*Bethlehem, Pa.*	119 W. D. H.
Charles Seward Wilcox	*Painesville, O.*	136 College st.
Walter Smith Williams	*Evanston, Ill.*	36 Elm st.
Charles Henry Wilmerding	*Hartford*	29 Prospect st.

JUNIORS, 56.

FRESHMAN CLASS.

Daniel Sidney Appleton	*New York City*	165 Temple st.
Charles Backus Ball	*New Britain*	113 Bailey st.
Edward Henry Ball	*Milwaukee, Wisc.*	165 Temple st.
Hartman Bache Borie	*Philadelphia, Pa.*	156 York st.
Harry Banning Bradford	*Wilmington, Del.*	169 Temple st.
Charles Sumner Brown	*Fair Haven*	25 Whitney av.
Joseph Arthur Chanute	*New York City*	128 High st.
George Huntington Clark	*Norwich*	20 Prospect st.
Arthur Baylies Coffin	*Edgartown, Mass.*	191 Temple st.
Edward Allen Colby	*St. Johnsbury, Vt.*	23 Prospect st.
Frank McAlpine Collin	*Penn Yan, N. Y.*	72 High st.
Peter Franklin Conway	*New Haven*	117 Washington st.
Charles Mabie Crouse	*Syracuse, N. Y.*	120 Chapel st.
Edward Merrill Currier	*Chelsea, Mass.*	14 Lock st.
Harry Sprague Davidson	*San Francisco, Cal.*	161 Temple st.
William Loami Davis	*Chicago, Ill.*	523 Chapel st.
Thomas Edward Doolittle	*Onarga, Ill.*	113 Olive st.
Jacob Edward Emery	*Fair Haven*	73 Exchange st.
George Robert Ferguson	*New Haven*	29 Sylvan av.
William Henry Fox	*Washington, D. C.*	25 Prospect st.
George Washington Gibson	*New Haven*	44 Edwards st.
George Edward Goodspeed	*East Haddam*	183 George st.
John Warren Hardenbergh	*Jersey City, N. J.*	117 Elm st.
Samuel Higgins	*Buffalo, N. Y.*	82 Wall st.
Louis Maynard Higginson	*Newburgh, N. Y.*	161 Temple st.
Walter Hitchcock	*Cheshire*	29 Prospect st.
Theodore Lanahan Hooper	*Baltimore, Md.*	169 Temple st.
James Barland Houston	*Enfield*	163 Temple st.
Frank Allison Hubbard	*Sandusky, O.*	121 Park st.
Colin Macrae Ingersoll	*New Haven*	85 Trumbull st.
Charles Henry Johnson	*Union, N. J.*	12 Trumbull st.

David Brown Lewis	*Utica, N. Y.*	12 Trumbull st.
Earnest Theophilus Liefeld	*New Haven*	36 Orchard st.
Richard Becker Lyon	*New Haven*	710 Chapel st
Willey Sollon McCrea	*Chicago, Ill.*	221 Elm st
Edwin Kirtland Morse	*Poland, O.*	29 College st
Carl Eugene Munger	*Watertown*	23 Prospect st
Edward Butler Needham	*Hartford*	191 Temple st
Frederic Adriance Osborn	*New Haven*	150 York st
John Irving Pearce	*Chicago, Ill.*	71 York st
George Benjamin Phelps	*Watertown, N. Y.*	84 Wall st
Dwight Porter	*Hartford*	14 Lock st.
Edgar Sheffield Porter	*New Haven*	38 Hillhouse av.
Edward Freeman Porter	*Stowe, Vt.*	23 Prospect st.
Joel Howard Reed	*Albany, N. Y.*	251 Church st.
Edwin McNeil Rogers	*Central City, Col.*	191 Temple st.
George Bliss Rogers	*Lexington, Mass.*	169 Temple st.
Isaac Marion Rosenthal	*Rochester, N. Y.*	35 How st.
William Bartlett Schofield	*West Point, N. Y.*	48 College st.
Henry Starkweather	*New Haven*	170 Martin st.
Elliott Joseph Stoddard	*Seymour*	80 Broad way
Schuyler Van Vechten	*Albany, N. Y.*	165 Temple st.
Adrian Rowe Wadsworth	*Farmington*	135 St. John st.
William Candee Warren	*Buffalo, N. Y.*	82 Wall st.
Adolph Frederic Wehner	*New Haven*	544 Chapel st.
George Goodman Williams	*Glastonbury*	133 College st.
Arthur Burnham Woodford	*West Winsted*	36 York sq.
William Henry Yale	*New York City*	201 Orange st.

FRESHMEN, 58

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Norton Bail	*New Haven*	43 Park st
Thomas Attwater Bostwick	*New Haven*	162 Olive st.
William Thomas Cochrane	*Durham, Ontario*	119 Greene st.
Caldwell Hart Colt	*Hartford*	165 Temple st.
Alfred Daggett	*New Haven*	9 Warren st.
Arthur Melancthon Diggles	*Tarrytown, N. Y.*	55 Trumbull st.
Joseph Caldwell Earle	*New Haven*	214 Orchard st.
Robert Haggert	*Brompton, Ontario*	119 Greene st.
Charles Wilbur Nichols	*Bridgeport*	Bridgeport
Edward H. Phipps	*New Haven*	144 Chapel st.
Benjamin Silliman Warner	*Pomfret*	34 Hillhouse av.
Walter Watson	*Northampton, Mass.*	90 Grove st.
Charles Wilson Whittlesey	*New Haven*	524 Chapel st.
Eugene Benjamin Wilson	*Elizabeth, N. J.*	147 York st.

SPECIAL STUDENTS, 14.

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially *since the autumn of 1869*, numerous liberal gifts have

been received from the citizens of New Haven, and from othe gentlemen in Connecticut, New York, and St. Louis, for th endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a Stat Board of Visitors, consisting of the Governor, Lieutenant-Gov ernor, three senior Senators, and the Secretary of the State Boar of Education; and this Board, with the Secretary of the Scien tific School, is also the Board for the appointment of students t hold the State scholarships.

At the request of the Governing Board, the Corporation c Yale College has also appointed a Board of Councillors for th School, consisting of a number of gentlemen who have taken deep interest in its welfare.

The Governing Board consists of the President of Yale Co lege and the Professors who are permanently attached to th School. There are several other instructors associated with them a part of whom are connected with other departments of th College.

III.

BUILDING AND APPARATUS.

The two buildings in which the work of instruction in th Scientific School is mainly carried on are called Sheffield Hall an North Sheffield Hall; but instruction in Mineralogy, Geology and Biology, including Zoology and Comparative Anatomy, now given entirely in the Peabody Museum. These halls con tain a large number of recitation and lecture rooms, a hall f public assemblies and lectures, chemical and metallurgical labo tories, a photographical room, an astronomical observatory museums, a library and reading room, besides studies for some the professors, where their private technical libraries are kep

The following is a summary statement of the collections belong ing to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy. Physics, Photography and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons o Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

7. Models in Architecture, Geometrical Drawing. Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments

of the University. This degree is conferred upon those who, hav ing already taken a Bachelor's degree, engage as students in th Department of Philosophy and the Arts for not less than tw years in assiduous and successful study. It is not given upon ex amination to those whose studies are pursued elsewhere. The re quirements for it will in some cases exact of the student more tha two years of post-graduate labor; so, especially, wherever th course of undergraduate study has been, as in the Scientific Schoo of less than four years. The candidate must pass a satisfactor final examination, and present a thesis giving evidence of hig attainment in the branches of knowledge to which he has attended A good knowledge of Latin, German and French will be require in all cases, unless, for some exceptional reason, the candidate b excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as fo lows:—

Professor NORTON will instruct in applied mechanics and i spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomi cal instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of minera species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultura chemistry.

Professor BREWER, in agriculture and forest culture, in the us of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of in dustry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geol ogy.

The same courses of study are open, for a longer or shorter time

to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus. General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics.) Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor *of Dynamic Engineering*, and under such *circumstances as shall appear to him* to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.- For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Algebra—So much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid, and spherical; including fundamental notions of symmetry and examples of Loci and of Maxima and Minima of Plane Figures:—an equivalent to the nine books of Chauvenet's Treatise, or to the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry, Boston, 1877.

In his preparation in GEOMETRY the candidate should, as far as practicable, *have suitable exercises* in proving simple theorems and solving simple problems

for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Among other works, Todhunter's "Trigonometry for Beginners" will furnish the judicious teacher much material for this class of exercises. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of Logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat, orderly, and readily intelligible arrangement.

In LATIN, in order to assure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant, merely, such a course of elementary exercies in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature or the extent of the requirement, the following works are specifically named, among which the candidate for examination may make his own selection. These are Harkness' "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; or McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

In ENGLISH, Whitney's Essentials of English Grammar (Ginn and Heath, Boston) is recommended for the examination of 1878; in the examination of 1879 it will be required.

The requirement in Physics, previously existing, is discontinued for the present, the text-book recommended having been withdrawn by the publishers.

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, June 28, 29; and on Tuesday and Wednesday, September 10, 11, 1878. Opportunities for private examination may, in exceptional cases, be given at other times.

In 1878 an examination will also be held in Chicago (beginning on Friday, June 28, at 9 A. M.), at a place to be announced in the Chicago newspapers *of the day previous.*

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamic (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*—Plane Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing*—as stated above. *Mathematics*—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation; Analytical Geometry in Space; Spherical Trigonometry. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Qualitative Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—Laboratory Practice—Quantitative Analysis. *Mineralogy*—*Blowpipe Analysis* and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Agricultural Chemistry*—Recitations and Lectures (optional). *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*—Lectures.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Differential and Integral Calculus. Descriptive Geometry. *Surveying*—Field Operations. *Drawing*—Binns' Orthographic Projections. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. Descriptive Geometry. *Drawing*—Projection of Shadows and Perspective. Topographical. Warped Surfaces. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*—Stone Cutting—with graphical problems. Mahan's Civil Engineering. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Resistance of Materials. Bridges and Roofs. Building Materials. Stability of Arches and Walls. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—Differential and Integral Calculus. Descriptive Geometry. The use of the Level, Theodolite, and Transit. Instrumental Drawing. *German. French.*

SECOND TERM—Integral Calculus. Rational Mechanics. Instrumental Drawing. General Theory of Motion, and Principles of Mechanism. *German. French.*

SENIOR YEAR:

FIRST TERM—Principles of Mechanism. Applications of the Principles of Mechanics to Machinery. Machine Construction. Blowpipe Analysis. Resistance of Materials. Construction of roof trusses, girders, and iron bridges. Machine Drawing. *Geology. French.*

SECOND TERM—General principles of Heat employed as a source of power. The construction of Steam Generators. Steam Engines. Hot Air Engines. Water Engines. Water Wheels. The Construction of Water Reservoirs, and Conduits. Measurement of Water Supply. Discharge of Pipes, etc. Graphical Statics. Machine Designing. *Metallurgy. Geology.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Qualitative sis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. Fre*

SECOND TERM — *Laboratory Practice*—Quantitative Analysis. *Minera* Blowpipe Analysis and Determination of Species. *Physical Geography*—L *Botany*—Lectures. *French. German.*

SENIOR YEAR.

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the N States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *iology*—Huxley's. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Br Lectures. *Geology*—Dana's. *Rural Economy*—History of Agricultur Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *A tural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Micr English. French.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the pr study, some attention in each case being directed to the other three branc Natural History.)

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis. Laboratory Practice. tions. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. —Gray's Manual; Use of the Microscope. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice. Excursions (land and m *Botany*—Laboratory Practice. Thomé's Text-book. Excursions. *Miner* continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory P Lectures. Excursions. *Botany*—Herbarium Studies. Excursions. *Physi* Huxley. *Linguistics*—Whitney's Life and Growth of Language. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. Laboratory Practice. Lectures. *Botany*—Herbarium Studies, especially Cryptogamous Orders. Botanical Literature. Essays in Descriptive I *Meteorology. French.*

Besides the regular courses of recitation and lectures on structural and s atic Zoology and Botany, and on special subjects, students are taught to p arrange, and identify collections, to make dissections, to pursue original inv tions, and to describe genera and species in the language of science. Fo purposes, large collections in Zoology and Palæontology belonging to the are available, as are also the private botanical collections of Professor Eatc

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

During the Junior year, the work of this course is chiefly under the direction of the instructors in Chemistry. Especial attention is given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In Toxicology the organic and mineral poisons are carefully studied. The special studies of the Senior year are wholly biological, particular attention being paid to the elements of comparative anatomy, histology, and physiology, to structural and physiological botany, and to systematic zoology. Instruction is also given in embryology, the laws of heredity, and human parasites. The order of studies is as follows:

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis—Fresenius'. Laboratory Practice. Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Physiological Chemistry*—Klein's Handbook. *Toxicology*—Fresenius'. Laboratory practice. Recitations. Lectures. *Botany*—Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *Mineralogy*—continued. *German. French.*

SENIOR YEAR:

FIRST TERM—*Comparative Anatomy and Histology*—Laboratory Practice. *Physiology*—Huxley's, with Practical Exercises. *Botany*—Practical Exercises. Lectures, and Excursions. *Geology*—Dana's Manual. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Botany*—Lectures. Laboratory Practice in Cryptogamia, etc. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot. Lectures. *Botany*—Lectures and Excursions and Laboratory Practice. *English*—Chaucer, Shakespeare. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lecture Excursions. *Linguistics*—Whitney's Life and Growth of Language. *En* Shakespeare. *History*—Constitutional History of the United States. Le *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology and Zoology*—continued. *Meteorology*—Lectures *litical Economy*—Lectures. *English*—Shakespeare, Milton, Dryden, Pope. *tory*—Political History of the United States. History of Europe since 1848 tures. *French.*

Exercises in English Composition are required during the e course from all the students. The preparation of gradu theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually giv

DRAWING.—The course in drawing extends through the t years. During the first term of Freshman year, the stud practice free-hand drawing at the Art School building, u the direction of Professor Niemeyer, of the Yale Schoo the Fine Arts. After the completion of the course in free-l drawing, instruction is given by Mr. F. R. Honey, during second term, in the elementary principles of instrumental draw embracing the whole of Binn's first course of orthographic pr tions, and Descriptive Geometry as far as warped surfaces. course is obligatory upon all.

During the Junior and Senior years, instruction in drawin obligatory only on the students in Civil and Mechanical En eering. In the former year the system of instruction embr Binn's second course in orthographic projections, isometric d ing, shades and shadows, tinting, perspective, and warped faces. By this method all the problems in Descriptive Geom are required to be worked out on the drawing-board instea the black-board. The course extends through the entire y and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principl drawing already obtained to works of construction, under general supervision of the Professors of Civil and of Dyna Engineering.

VII.

METHODS OF INSTRUCTION.

The instructions of this institution are given chiefly in small class rooms, recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of Marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity Church (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on page 43.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 42.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 12, 1878. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 30.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 25, 1878, and at or about the same time in the year 1879, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

THIRTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1878-79.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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1879.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors of the Sheffield Scientific School have the honor to transmit herewith the Annual Report of the Governing Board of that institution. By it the progress of the school, and the exceeding value of the educational work which it is doing, will be seen at a glance. We take pleasure in saying that a more zealous, devoted and competent staff of professors is not to be found. By their persevering efforts and the noble generosity of Mr. Sheffield, the institution has grown from small beginnings, in an incredibly short space of time, to be as we believe, the most thorough and complete scientific school in the whole country. The people of the State are too little aware of its value, considered merely as a means of industrial education. Let one illustration of its uses stand for many. The people of our State easily excel all others in the inventive faculty. It is this faculty which perhaps more than any other adds to the material comforts and conveniences of social life and to the wealth of the State. Let any one glance at the course of studies taught by this School in Dynamical Engineering as set forth in the present report of the Governing Board, and he will see that it is just what is most wanted to-day for the development and education of the inventive genius of the State and for continued progress in the Mechanical Arts.

We beg leave again to state, as we took occasion to do in our last report,—and we repeat it now for the purpose of giving still more publicity to the fact, and of keeping it constantly alive in the public mind,—that there are no less than thirty scholarships in this school that are to be had by any poor and deserving applicant for the mere asking. A highway is thus opened up from the common schools into optional and special courses of study in the highest ranges of the working sciences, and every poor man's son in the State *ought to know it.* This fact is one of the most signi-

ficant and interesting developments in the whole history of modern popular education. It is an added opportunity,—and a very noble one,—for the sons of the poorer classes to emancipate themselves from hard conditions, and pass up into higher and better. In this point of view we regard it as one of the very best tendencies of the democratic institutions of our State. Whilst commending the general merits of this school as most useful and excellent, we beg to emphasize to the utmost this feature of it. There ought to be at least as much competition for these free scholarships as there is for the prizes of a regatta, a ball club, or a target shoot. It does not speak well for the reputation of our State, or the educational spirit of our young men that it is far otherwise.

By order of the Board.

R. D. HUBBARD,
Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Thirteenth Annual Report, the Governing Board of the Sheffield Scientific School have deemed it wise to call the attention of the Legislature and the public to the facilities now furnished for the study of Mechanical or Dynamic Engineering. The general prostration of business throughout the country has temporarily affected to a large extent, as is well known, the demand for proficients in Civil Engineering. For Dynamic Engineers there is, however, a steady call; and the Governing Board have, during the past year, devoted much attention to improving and perfecting the course of study in this department. It has been thought proper in consequence, to state fully the method of instruction now carried on in this branch; and for it we ask the consideration of those who are interested in the development of engineering applied to the mechanic arts, and of the institutions which seek to prepare young men for the callings in which a theoretical knowledge of the principles of Dynamic Engineering is advantageous, if not absolutely essential.

Course in Dynamic Engineering.

Object of the course.

The object of this course is to furnish such a preliminary training as shall best qualify the student to follow with success the profession of a mechanical engineer, to enable him to properly design machinery and to superintend its construction in the shop, and to prepare him as thoroughly as possible, by study and practice, for the various duties which the mechanical engineer may be called upon to fulfill, such as shop management, the testing and examination of *machinery, the* measurement of the power fur-

nished by machines, the arrangement of machine plans, and the duties of an expert generally; to furnish him with the ability to put into proper shape the ideas of the constructor and inventor, and, so far as in him lies, to invent new forms and combinations himself.

The dynamic engineer should be both a constructor and an inventor, as well; should combine theoretical knowledge with practical experience; and just in the degree in which he does this will be his chances of success in his profession.

How far these demands can be met in a preliminary course of collegiate instruction, and just what is the best way of meeting them, and of giving to the young student the best possible preparation for the work which lies before him after graduation, are questions which yet wait for solution. The number of the Institutions in which such a course of instruction is attempted, illustrate the diversity of views which prevail, and indicate as well, the wide-spread demand which exists for well trained mechanical engineers. In fact, the field of employment open to the competent graduate in the direction of mechanical engineering, is of wider extent and holds out greater inducements of speedy, permanent and profitable employment, than in almost any other line of technical study. Nearly every branch of commercial and industrial enterprise,—mines, furnaces, mills, ships, railroads and manufactories of all kinds—offer to trained ability, abundant and lucrative occupation, and the prospect of speedy personal independence. The old established course, and the old designation of "Civil Engineer," no longer cover the wide field which has been opened up by the rapid development of later years. As a consequence of such development, which has been mainly due to the introduction of machinery in nearly every direction of human industry, we have the wide-spread demand above alluded to; a demand which it becomes the duty of our technical schools to recognize and provide for, and which, accordingly, as early as 1863, was recognized by the Governing Board of the Sheffield Scientific School by the institution of a separate course of instruction in mechanical engineering.

EQUIPMENT OF THE DEPARTMENT.

The Department now possesses for the purposes of instruction a large and well selected cabinet of Mechanical Models and *apparatus,* originally the gift of M. Dwight Collier, Esq., of St. *Louis, as a memorial* of his brother, Thomas F. Collier, who for

two years previous to his death, in 1868, had been a member of the School. This collection has since been greatly increased by purchases abroad, and by the generous gifts of many friends of the School at home. Through the kindness of Howard Potter, Esq., the School also possesses the entire collection of working plans and drawings of the Novelty Iron Works, numbering several thousand, an accumulation of twenty-five years, illustrating entire and in detail the large variety of constructions there manufactured. A full catalogue of these drawings will be found in the Sixth Annual Report of the School. They have been all brought together, conveniently arranged for reference, and form an invaluable aid in the course of instruction. The libraries both of the College and of the School are free of access to all the students.

RELATION OF THEORY AND PRACTICE.

Such, in brief, is the object of the course, and such are the means at disposal for attaining it. A few words may not be out of place as to the methods pursued in the work of instruction and the reasons which render such methods desirable. As already intimated, a great diversity of views prevails as to what should constitute the best training for a mechanical engineer. Such diversity is perhaps better accounted for by the special circumstances and limitations under which our technical schools are required to work, rather than by any real difference of opinion as to the end to be attained and the subjects necessary to be taught. The object in view, as already stated, is so to train the student in "such branches of learning as are related to the mechanic arts," as to qualify him to contribute toward the more efficient prosecution of these arts and render him able to design, construct, superintend and invent machinery of all kinds. Circumstances must largely mould and regulate the methods by which this end is sought to be attained, as well as the degree in which it is attained. It is, of course, not to be expected that within the limits of a short collegiate course, a full practical knowledge of details of professional work can be acquired. Even were this possible, it is questionable whether the time at disposal would be thus utilized to the best advantage. Principles, not practice, must be ever the leading object, and these principles properly acquired and apprehended, the student can be trusted to acquire the details by the experience which the practice of his profession must inevitably bring. Indeed, *it is only by practice* and experience that such

details can be properly learned at all; while without a thoroug knowledge of the principles involved, even practice and exper ence must fail to bring forth their legitimate fruits. A thoroug theoretical training is, therefore, an essential, and such it earnestly endeavored to give. Moreover, at no other time of h life is the student so well able to obtain such a training, while tl practical details are the natural growth of years of application the fundamental principles thus early acquired. At the same tin it can not be forgotten that the student has a right to expe something more than a mere theoretical training, howev thorough, as the result of five years of earnest labor. He has right to expect that, upon graduation, he shall have a usefi practical knowledge of professional details, of such an extent shall render his services immediately and directly valuable, ar furnish him with at least the means of subsistence and with imm diate employment. This is an essential for any successful tec nical course. Without it the student might better, so far as an immediate remuneration is considered, start at once in some su ordinate position in the shop, and even if in the end the mo thoroughly prepared graduate ought, theoretically, to come o ahead of his untrained competitor who started earlier in the sho he can hardly be expected to properly realize at such an earl stage the advantages of such a preparation, nor to give the lengt of time necessary to practically test its value. Moreover, as matter of fact, he would not always come out ahead. Earnestne of purpose and the stress of necessity, may often enable tl apprentice to outstrip his more favored and sometimes more ind lent competitor. With the theoretical training, therefore, it absolutely essential that so much of detail should be joined, shall render the student commercially valuable and secure him standing and a starting place in his profession. So much necessary. More than this is not essential, although in so far it does not encroach upon thorough theoretical training, the mo of practice the better.

The manufacturer, on the other hand, who may employ such graduate of a technical institution, has, in turn, a right to e pect that his services shall be at least worth his pay, while is acquiring in the shop those practical details which are nec sary to supplement and complete his course. However rapidly t training may enable the graduate student to outstrip his le *thoroughly* prepared non-graduate competitor, the employer c

hardly be expected to both teach and support him through this stage of his career, especially when the knowledge thus obtained at his employer's expense goes ultimately to benefit some one else. We cannot thus turn our manufacturing establishments into training schools for the finishing of our graduates and expect them not only to give free tuition, but to pay their students as well. The above remarks are worth the attention of manufacturers, who are sometimes prone to expect too much from a young graduate in the first instance, and to put him at once, on the mere recommendation of his diploma and the reputation of the school from which he gets it, at work for which he is eminently unfit, and then going very naturally to the other extreme, upon the natural failure of the young man to meet these extravagant expectations, to depreciate and undervalue the real worth of the special training and preparation imparted by the school. Let it be understood then, by students and employers alike, that skilled engineers are not and cannot be made to order by this or any other School. A good foundation only can be laid, upon which the student must build for himself according to his own ability, industry, and opportunities, and, in addition to this, he should bring a certain but necessarily very limited amount of special knowledge which ought to be sufficient, at least, to pay his way while he builds. He is well trained in the *science* of mechanics, but has most of his *trade* still to learn. If understood thus, graduated students would often be spared much weary and profitless waiting and their employers much disappointment and perhaps pecuniary loss.

The two objects held in view, then, throughout the course, are 1st, *A thorough theoretical training;* 2d, *A sufficient practical knowledge in certain directions, to secure and to be worth remuneration.*

COURSE OF INSTRUCTION.

These objects are sought to be secured as follows: The full course occupies five years. The first year is, as given elsewhere in this Report, common to all the courses. The second year follows closely the course as laid down for Civil Engineering. The distinction between Civil and Dynamic Engineering, lies in the fact that, while the problems of the first are problems of stability, and involve the necessary condition of rest or permanence, as exemplified in bridges, roofs, dams, earthworks, and the like, those of the second involve the application of motion and force for the performance of desired results, as exemplified in machines

of various kinds. The object of the one is to resist the action of natural forces, and, even in spite of them, to ensure and secure permanence and stability; of the other, to guide and control the action of these forces and by making use of them, to secure the end in view, which is generally the performance of work or the transmission of motion or power from one point to another. The elementary studies, it is therefore evident, must be to a large extent, common to both branches. The various forces of nature, their laws of action and the methods of investigating and studying them, must be familiar both to the Civil and Dynamic Engineer. As, however, the one has to combat and counteract the action of these forces while the other has to guide and modify their effects, there must be a divergence as the student advances. The second year, therefore, is very similar, as will be seen from the schedule of studies, in both courses, while in the third year there is a marked divergence. Up to this point, the student has obtained a fair knowledge of French and German, of Physics and Elementary Chemistry, is well trained in the Mathematics, including Analytical Geometry and the Differential and Integral Calculus, and has been specially drilled in Instrumental Drawing and Descriptive Geometry. These latter forming as they do, the foundation of his practical training, and being essential to future success, are taught with great thoroughness and in detail. The student learns to represent accurately and to scale, any construction, and to put into concrete form, in the shape of an accurate working drawing, any ideal combination of parts for the attainment of any desired result.

In the third year, the divergence is complete. While in the direction of theory, applying his mathematical knowledge in various directions, such as the application of mechanics to machinery, and becoming familiar with the principles which govern the construction of various machines, such as Steam Engines, Air Engines, etc.; with the fundamental principles of Hydraulics and Hydraulic Motors; the student at the same time pursues an extended course of *machine designing*, in which he learns to apply not only all new principles as he acquires them, but also his knowledge of the Strength of Materials, the Principles of Mechanism and Descriptive Geometry already obtained. He is made to consider one by one all the various parts which all machines possess and *their* mutual relations; is taught to design them one by one, and, *while designing*, has pointed out to him their various uses, the

processes involved in their construction and the rules for proportioning them. Then, passing on from the simple to the more complex, he designs working drawings for projected machines. When rational formulæ are not applicable, empirical rules deduced from the best practice, for the dimensions of the various parts are given him, and the work in the Drawing Room, which forms a very important feature of the course, is conducted as nearly as possible in all respects like that in the draughting room of an engineering establishment. The course is supplemented by shop visits, in and out of the city, and attention is directed to the important points of fitting, founding, forging and pattern-making, and all the principal processes involved in machine construction. By these means, by lectures upon the above processes, and by recitations, it is believed that the student can obtain such a knowledge as shall render him an acceptable and profitable acquisition to the manufacturer and machine constructor. The fourth year continues the course just indicated. In addition to the course elsewhere laid down in this Report, and a special course of reading under the direction of the professor, the student is required to examine and report upon existing machines, to design machines for various purposes according to given data, and to complete his course in the draughting room. Arrangements are made by which such students can make trips upon locomotives and steamboats for the purpose of examination, take indicator diagrams and make reports, and a certain number of such trips and reports are required from every student. The year closes with the preparation and presentation by the student of a thesis upon some special subject, giving evidence of application and ability in the studies he has pursued. The fifth year must be spent by the student either in actual professional practice, in the examination of engineering works and manufacturing establishments, or in some subordinate position in such works or establishments. During this time the student will be in constant communication with the professor and will engage in such work only as shall appear to be favorable to professional progress.

All the lectures of the University which have any bearing upon his profession, are open to the student during the last two years, such as those upon Political Economy, Patent Law, and The Law of Contracts; and opportunity is offered him to take the Field-work with the Civil Engineers, and so much of Practical Astronomy as is requisite *for the determination of* Latitude and Longitude.

Connecticut Agricultural Experiment Station.

The Connecticut Agricultural Experiment Station still co tinues to have the use of three rooms and the eastern entrance i Sheffield Hall. The other appliances of the School have al been freely used, whenever necessary, by this important Sta Institution, and, as heretofore, free of charge to the Station. Th occupation of the eastern wing by the Experiment Station h made it necessary to provide elsewhere for the increasing wan of the students of Physiological Chemistry, and another labo tory on the second floor of the western wing has been given for that use.

It is perhaps proper to add here that the New Haven Coun Farmers' Club has had the free use of rooms in Sheffield Hall, f their meetings. This association holds eighteen regular meetin each year, viz: on the first and third Fridays of each mon from October to April, and on the first Friday of each mon during the other six months. The meetings have been large an well attended.

The New Haven County Agricultural Society has also had th use of rooms for its meetings.

National Agricultural Congress.

The National Agricultural Congress held its annual meeting i North Sheffield Hall, beginning August 27th, 1878.

The sessions continued three days, and were attended by a larg number of persons representing many States of the Union.

Public Lectures.

The twelfth annual course of lectures to mechanics and other was given during the past year in the lecture room in Nort Sheffield Hall. The lecturers and their subjects are indicated i the following programme.

I.	Thurs., Feb.	7.—British Savings Banks.	Prof. Walke
II.	Monday, "	11.—Ferns.	Prof. Eato
III.	Friday, "	15.—The Story of the Northumbrian Gospels.	Prof. Lounsbur
IV.	Monday, "	18.—The Great Pyramid.	Prof. J. D. Whitney, of Harvard Colleg
V.	Thurs., "	21.—Torpedoes.	Gen. H. L. Abbot, U. S. Engineer Corp
VI.	*Monday,* "	25.—Development of Oöspores in Seaweeds.	Prof. Eato
VII.	*Thurs.,* "	28.—Quetelet's Researches on Man.	Prof. Clar

VIII.	Mon., Mar.	4.—The Atomic Theory.	Prof. Johnson.
IX.	Thurs., "	7.—History of the Art of Writing.	Prof. W. D. Whitney.
X.	Monday, "	11.—American Savings Banks.	Prof. Walker.
XI.	Thurs., "	14.—Relations of Meteorites to Comets.	Prof. Newton.
XII.	Monday, "	18.—Niagara Falls.	Prof. Brewer.
XIII.	Thurs., "	21.—Niagara Falls.	Prof. Brewer.

Lectures on Military Science.

A course of lectures on military science, by officers of the U. S. Engineering School, at Willet's Point, was delivered in North Sheffield Hall as a part of the instruction in the school during the second term of the academic year 1877–78. The order and subjects of the lectures were as follows:

I.	Friday, Feb.	1.—Strategy and Grand Tactics.	Capt. W. D. Livermore, U. S. Engineers.
II.	Tuesday, "	5.—Logistics.	Capt. T. H. Handbury, U. S. Engineers.
III.	Friday, "	8.—Small Arms and their influence on Tactics.	Lieut. B. D. Greene, U. S. Engineers.
IV.	Tuesday, "	12.—Ordnance and Gunnery.	Lieut. J. B. Quinn, U. S. Engineers.
V.	Friday, "	15.—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI.	Thurs., "	21.—Torpedoes.	General H. L. Abbot, U. S. Engineers.

Gifts.

A binocular compound microscope, with case and accessories, made by Beck, has been presented by Alonzo E. Wemple, Esq., of the class of 1875, and is a valuable addition to the apparatus of the Biological department of the School.

A complete set of the American Journal of Education, extending from 1855 to 1877, and embracing twenty-seven volumes, has been presented to the library of the School by Mr. Sheffield.

To Dr. Wolcott Gibbs, Rumford Professor of the Application of Science to the Useful Arts in Harvard University, the Library is also indebted for a generous gift of about one hundred and fifty volumes. The following is the list of the works presented.

Accum, F. Elements of Crystallography. London, 1813.

Agriculture, Department of, Reports for 1873 and '75. 2 vols. Washington 1874 and '76.

American Almanac. 1830–61. 32 vols., bound in 19 vols. Boston, 1829–61.

American Association for the Advancement of Science, Proceedings of the. 1845, '48–'51, '53, '55–'60. and '67. 15 vols.

American Chemical Society, Proceedings of the. New York, 1876.

American Geographical Society *of the State* of New York, Journal of the. 1870–71. *New York, 1873.*

Astor Library, Catalogue of the. 4 vols. New York, 1857–59 and '61.
Bulletin de la Société Chimique. 1861–72. 14 vols. Paris, 1861–72.
BURAT, M. A. Géologie Appliquée. Paris, 1846.
Canada, Geological Survey of. Reports 1853–56. Toronto, 1857.
Canadian Meteorological Report for 1876. Ottawa, 1877.
COX, E. T. Geological Survey of Indiana. Reports for 1873 and 1875. 2 vols. Indianapolis, 1874 and 1876.
DALE, T. N. Study of the Rhaetic Strata of the Val Di Ledro. Patterson, 1876.
EISENLOHR, W. Lehrbuch der Physik. Stuttgart, 1857.
FENWICK, S. See *Rutherford, W.*
GAUSS, C. F. and WEBER, W. Resultate aus den Beobachtungen des Magnetischen Vereins im Jahre 1836, 1838–41. 5 vols. Leipzig, 1837–42.
GERHARDT, C. Introduction à L'Étude de la Chimie. Paris, 1848.
GILBERT'S Annalen der Physik. Vols. 1–78. 78 vols. Halle, 1799–1808. Leipzig, 1809–24.
GUYÔT, A. Meteorological Tables. Washington, 1852.
HAIDINGER, W. Handbuch der Mineralogie. Vienna, 1850.
JACKSON, C. Geology of Rhode Island. Providence, 1840.
JENCKEN, H. D. Treatise on Light, Color, Electricity and Magnetism. London, 1869.
KIDDER, J. H. Contributions to the Natural History of Kerguelen Island. Washington, 1876.
LIEBER, O. M. Geological Survey of South Carolina. Columbia, 1858.
LOUDON, J. C. Encyclopedia of Plants. London, 1836.
MCCLELLAN, G. B. Report of Mission sent to the Seat of War in Europe in 1855 and '56. Washington, 1857.
PÉCLET, E. Traité de Physique. 3 vols. Paris, 1847.
POUILLET, M. Élements de Physique Expérimentale et de Météorologie. 3 vols. Paris, 1853.
Quarterly Journal of Science. 1864 and '65. 2 vols. London, 1864 and '65.
RAMMELSBERG, C. F. Berzelius's Chemisches Mineral System. Nürnberg, 1847.
RAMMELSBERG, C. F. Wörterbuch der Mineralogie. 2 vols. Berlin, 1841.
Répertoire de Chimie Appliquée. I–V, 5 vols. Paris, 1858–63.
Répertoire de Chimie Pure. I–IV, 4 vols. Paris, 1858–62.
ROBINSON, S. Catalogue of American Minerals. Boston, 1825.
Royal Society, Proceedings of the. Vols. 11, 15, 17–19. 5 vols. London, 1860–71.
RUTHERFORD, W. and FENWICK, S. The Mathematician. Nos. 1–7, London, 1847.
SHUBARTH, E. L. Handbuch der Technischen Chemie. 4 vols. Berlin, 1851.
Texas Almanac for 1867. Galveston.
United States Circuit Court. (Equity). Rumford Chemical Works vs. John E. Sauer. New York, 1869.
United States Circuit Court. (Equity). R. A. Tilghman vs. R. G. Mitchell. New York, 1864.
WEBER, W. See *Gauss, C. F.*
WELTZIEN, C. Systematische Zusammenstellung der Organischen Verbindungen. Braunschweig, 1860.

From Mr. D. Cady Eaton, late Professor of the History and Criticism of Art in Yale College, the School has received a gift of the following large-size photographs of artizan work of the Middle Ages, and of later periods. The objects from which these photographs are taken, are contained in the National Museum of Bavaria, at Munich, and, as will be seen, comprise artizan work of a military, ecclesiastical, and domestic character.

1. Complete suit of Armor of Duke Henry the Pious of Saxony, born 1473, died 1544. Armor of steel inlaid with gold.
2. Complete suit of Armor of the Elector, Christian I. of Saxony, born 1560, died 1591. Steel etched with gold inlaid.
3. Complete suit of Armor of the Elector, Christian II. of Saxony, born 1583, died 1611. Italian work. Enchased in steel and gilded.
4. Complete suit of Armor of the Elector, Christian II. of Saxony, born 1583, died 1611. Wrought by Kollman in Augsburg. Enchased in steel overlaid with gilt ornaments.
5. Complete suit of Armor of Duke John William of Weimar, born 1530, died 1573. Steel etched and gilded.
6. Parade-armor of the Elector, Christian I., born 1560, died 1591. Copper gilded.
7. Parade-armor of Charles Emanuel, Duke of Savoy, born 1562, died 1630. Enchased in steel and gilded. Made in Milan.
8. The so-called Milan armor introduced into Germany by the Emperor Maximilian I. Made at Nuremberg, 1512–1545.
9. The same, from a different view.
10. Armor for a tournament on foot. Augsburg work. Etched upon steel.
11. Shield of the 16th Century. Augsburg work.
12. Shield of the 16th Century. Augsburg work.
13. Shield of the 16th Century. Italian work.
14. Hauberks of the 17th Century. Steel with silver inlaid, and steel-gilt with silver ornaments. 2 figures.
15. Helmet, 1460–1500.
16. German tournament-helmets, 1500–1550. 2 figures.
17. Milan Helmets, so-called. Nuremberg work, 1515–1540. 2 figures.
18. German Helmet with etched ornaments, 1550–1580.
19. Helmets of the 16th Century. Italian work. 2 figures.
20. Helmet (Spanish model) of the 16th century. Augsburg work.
21. Morions, 1590–1630. 2 figures.
22. Halberds, with wheel lock pistols, 1530–1560. 2 figures.
23. Halberds, etched and gilded, of the year 1588, and two of the same with double pistols. 3 figures.
24. Halberds with etched ornaments, 1550–1590. 5 figures.
25. Halberds and Partisans with etched ornaments, 1600–1640. 4 figures.
26. Indian Partisans bought in the year 1727 by Augustus the Strong. 2 figures.
27. Pistols of Saxon princes of the 16th Century. 4 figures.
28. Pistols of Saxon princes of the 16th Century. 4 figures.
29. Pistols of Saxon princes of the 16th Century. 4 figures.

30. Pistols of Saxon princes of the 16th Century. 4 figures.
31. Battle-axes, etched, 16th Century. 4 figures.
32. Battle-axes (for making a breach), 16th Century. 2 figures.
33. Battle-axes, etched, gilded, and damaskeened, 16th Century. 4 figures.
34. Carved Iron Parade Swords, with gold and silver inlaid, 1590–1640. 3 figures.
35. Gilt Iron Sword-hilts, gilded, 16th century. 3 figures.
36. Carved Iron Sword-hilts, gilded and inlaid with silver, 16th Century. 3 figures.
37. Carved Iron Sword-hilts. Nuremberg, 16th Century. 3 figures.
38. Carved Iron Sword-hilts, 16th Century. 4 figures.
39. Carved Iron Daggers, with Tauschir work in gold and silver. 8 figures.
40. Hangers with handles of stag-horn, ivory, and mother-of-pearl, 1700–1750. 9 figures.
41. Powder-flasks of stag-horn, 1550–1600. 8 figures.
42. Powder-flasks of ivory, 1670–1720. 9 figures.
43. Hunting-horn of the Roman time. Hunting-horn of the 17th Century. Powder-horns. Indian work of the 17th Century. 4 figures.
44. (*a*) Frontlet-armor of a horse, fluted, part of the Milan suit of armor. (*b*) Frontlet-armor of a horse, from the castle of Hohenaschen, with the escutcheon of the Lords of Freyberg, 1520–1540. 2 figures.
45. Embroidered Old-German Saddle with pistol holsters, 16th Century.
46. Old-German Saddle and Stirrups, 17th Century.
47. Spurs of Duke Christopher of Bavaria, with the Stirrups of silver-gilt. 2 figures.
48. Tools of the Elector Augustus, 16th Century. 4 figures.
49. Order of the Dragon, established by the Emperor Sigismund, 1389. Raised embroidery of silk and gold.
50. Gilded Badges of lead and bronze casting, and bronze ornaments, 1613–1661.
51. Monile of copper-gilt, with adoration of the three kings, wrought in silver, 1380–1440. 2 figures.
52. Bronze Reliquary, 1000–1050.
53. Fragments of an ivory Reliquary from the cathedral at Bamberg, 1000–1020. 3 figures.
54. Bronze Reliquary, 1000–1050.
55. Copper-gilt Reliquary, engraved and enamelled, 1150–1200.
56. Copper-gilt Reliquary, engraved and enamelled, 1170–1210.
57. Wooden Reliquary, 1460–1480.
58. Altar-piece in painted wood. Sculpture by Michael Bacher of Brunck, 1480–1500.
59. Painted wooden Altar-piece. After a design of Martin Schongauer, 1486.
60. Small Altar-piece in carved wood. Low Dutch school, 1490–1510.
61. Painted wooden Altar-piece with wings, 1500–1510.
62. Copper Pyx, fire-gilt, 1400–1430.
63. Iron Pyx, 1460–1500.
64. Monstrances of copper-gilt, 1460–1500. 3 figures.
65. Bishop's Crosier of ivory, 1710–1740.
66. Mitre with orient pearls. Mitre embroidered with silk, from the cathedral at Meissen, 15th century. 2 figures.

67. Two ivory Diptychs, and parts of Diptychs, 1300–1350. 7 figures.
68. Ivory Diptychs and parts of Diptychs, 1300–1350.
69. Painted wood Statue. St. Walpurgis, 1480–1500.
70. Painted wood Statue. St. Magdalen, 1480–1500.
71. Painted wood Sculpture. Lamentation over the body of Christ, 1490–1510.
72. Sculpture from Pear-tree wood. The Burial of Christ, 1496.
73. Painted wood Sculpture. The Body of Christ, the Virgin Mary, and St. Roch, 1500–1520.
74. Wood Sculptures of Fielman Riemenschneider. St. Peter, St. Paul, St. Simon, and St. Andrew, 1500–1520.
75. Wood Sculptures by the same. St. John, St. Philip, St. Bartholomew, and St. Thomas, 1500–1520.
76. Wood Sculptures by the same. St. Matthias, St. Jude, St. James the Greater, St. James the Less.
77. Painted wood Sculptures. The Four Evangelists, 1520-1540.
78. Painted wood Sculpture. Death of the Virgin Mary, 1580–1600.
79. Wood Sculpture. (*a*) Milan Coat-of-arms with lancers as shield supporters. From the castle at Passau. (*b*) End Rosette of a wooden ceiling.
80. Wood Busts from the castle at Neuberg, 1520–1540. 2 figures.
81. Linden-wood Sculptures. Two Knights of Leoprichting, 1520–1540.
82. Alabaster Sculpture. The Annunciation, 1460–1480.
83. Ivory work. Munich school, 1600–1650. 3 figures.
84. Ivory work. Munich school, 1600–1650. 3 figures.
85. The same, another view.
86. Ivory work, 1630–1660. 3 figures.
87. Ivory Sculptures. Bacchanals, by Antonius Leoni of Venice, 1690–1700.
88. Group of painted Porcelain. Frankenthal make, 1755–1761.
89. Oak-wood Ornaments. 1440–1480.
90. Linden-wood Ornaments, 1530–1560. 5 figures.
91. Linden-wood Ornaments, by Peter Floetner of Nuremberg, 1520–1546. 10 figures.
92. Ornaments of wrought Iron, 1700–1740. 8 figures.
93. Lead Castings from the work-shops of Nuremberg and Augsburg artificers as models for gold and silver smiths, 1560–1620. 10 figures.
94. Middle and Corner Borders of Book-covers, brass casting. 12 figures.
95. Fibulae of bronze, silver, and gold from the graves at Nordendorf, 500–900. 23 figures.
96. Silver Ornaments, 1640–1710. 49 figures.
97. Silver Ornaments for women. Girdles with knife-sheaths, 1660–1720. 2 figures.
98. Mother-of-pearl work, 1450–1500. 28 figures.
99. Silver Filagree work, 1660–1740. 26 figures.
100. Silver Filagree work, 1660–1740. 14 figures.
101. Linen with embroidered ornaments, 1380–1400. 3 figures.
102. Cloth Tapestry with figures representing the Beheading of John the Baptist, and the Twelve Months, 1560–1590.
103. Canvas Tapestry, 1590–1620.
104. Linen and Lace Table-cover. After the designs of Siebmacher, 1600–1640.

105. Altar-cloth of white Lace embroidered with gold, 1600–1650.
106. View of the Schramonplatz at Munich. Painting on linen in water c 1634.
107. Cloth of Gold woven with silk, 1690–1720.
108. Mantel of Violet-colored Velvet embroidered with gold, of Duke Willia which he wore at his marriage with Reneé of Lorraine, Feb. 22, Front view.
109. The same, view of the back.
110. Portrait of Duke Louis of Bavaria, brother of William IV., painted by Werlinger, 1516.
111. Falconry Bag of the Elector, Maximilian I., of Bavaria.
112. Ladies' leather Work-bags, 1510–1540. 3 figures.
113. Initial Letters on Parchment, 1490–1510.
114. Viola di Gamba of the Elector, John William of the Palatinate, ma Joachim Filke in Hamburg, 1697.
115. Chess-board of wood, and painted, 1490–1510.
116. Chess-board with inlaid engraved sculptured ivory, mother-of-pearl metal. After designs by Georg Penz, Heinrich Aldegrever, and Sebald Behan, 1520–1540.
117. The same. View of the inside.
118. Backgammon Board. Pieces containing portraits of German princes, Century.
119. Standing Clock, wrought and chiselled in silver, made by Christ Schende, in Augsburg, 1650–1670.
120. Clock of the 17th Century.
121. Looking-glass, with Frame carved from pear-tree wood. Dutch 1560–1600.
122. Frame carved in knee-timber, 1620–1640.
123. Ornamental Cabinet of ivory and copper-gilt, 800–900.
124. Small wooden Chest with colored lining, 1440–1470.
125. Chest with gilded lead filagree work, 1440–1480.
126. Linden-wood Chest with colored lining, 1460–1480.
127. Money Chest of iron, etched, 1560–1590.
128. Money Chest of iron, with colored lining, 1480–1510.
129. Carved and inlaid Chest, with piano-forte, 1580–1620.
130. Martin Luther's Cabinet. Gift of the Elector, John Frederick, 16th Cer
131. Clay Stove-Tile, with colored glazing, 1460–1500.
132. Ink-stand of wrought iron of the Elector, Charles Theodore of Ba 1750–1790.
133. Spinning-wheels, 1620–1660. 2 figures.
134. Chairs with carved work, and with the coat of arms of the Lords of I 1560–1590. 3 figures.
135. Chairs with carved work, 1560–1600. 3 figures.
136. Plate of Venetian glass, 1550–1600.
137. Limousin Plates by Pierre Cortoys, 1558. 2 figures.
138. Tin Plates of Caspar Enderlein, Nuremberg, 1600–1620. 2 figures.
139. Table-top of a piece of Cypress-wood, Nuremberg, 17th Century.
140. Tin Tankards, 1540–1600. 4 figures.

141. Cologne Pitchers of stone-ware, 1569–1591. 4 figures.
142. Cologne Pitchers of stone-ware, 1600–1630. 3 figures.
143. Mass Service of rock crystal and silver-gilt, 1600–1630. 2 figures.
144. Venetian Glasses, 1580–1600. 3 figures.
145. Venetian Glasses, 1650–1700. 3 figures.
146. Venetian Glasses, 1650–1700. 5 figures.
147. Glass Drinking-cup, with colored and gold ornaments and figures burnt in; made at Damascus, 1260–1300.
148. Drinking-horn of the 15th Century.
149. Silver Drinking Cup of the Burgomaster Gletzle of Ingolstadt, 1450–1470.
150. Drinking Cup of silver coin of Duke John George of Saxony, 1634. Ivory Drinking Cup with silver-gilt stand and cover of the same period. 2 figures.
151. Drinking Cups of carved cocoa-nut wood, 17th Century. 3 figures.
152. Ivory Drinking Cup with silver-gilt stand, cover, and handle. Munich work, 1630–1660.
153. The same. Another view.
154. Silver Drinking Vessels. One a Wedding Beaker in the form of a woman. No date. 3 figures.
155. Ivory Goblet and Candle-sticks, 1680–1700. 3 figures.
156. Bronze Candlesticks, 1100–1150. 3 figures.
157. Candlesticks of cast bronze, 1140–1200. 3 figures.
158. Turned ivory Candlesticks of the Elector, Maximilian I. of Bavaria, 1620–1640. 3 figures.
159. Ivory Knife and Fork Handles, 1680–1720. 18 figures.
160. Hunting Knives of the 17th Century. 5 figures.
161. Keys, 1650–1700. 15 figures.
162. Lock of a Bridal Chest with etched ornaments, 1530–1550.
163. Lock of a Bridal Chest with etched ornaments, 1530–1550. Tinned.
164. Lock-smith work, 1540–1580. 4 figures.

The following gifts have been made to the Department of Dynamic Engineering:

One No. 1 Sturtevant Blower, from B. F. Sturtevant, of Boston; one tablet of machine-made set-screws, from the Hartford Machine Screw Co.; Babbitt boxes for connecting rod, from the Colt's Pat. Fire Arms Mfg. Co., of Hartford; and one book of shapes (catalogue) from the Union Iron Co., of Buffalo, N. Y., by the favor of H. B. Bigelow, Esq., of New Haven.

Additions to the Zoological Collection.

A. E. Verrill, Curator; E. B. Wilson, Assistant.

During the past year rapid progress has been made in the arrangement, mounting and labelling of the collections. In the room (No. 12) devoted to vertebrata, the arrangement of the birds, reptiles and fishes has been nearly completed and many

additions have been made, particularly to the special New England series, while as many of the more interesting or important of the foreign bird skins as our very limited funds would permit have been mounted. In room No. 16, numerous additions have been made, and most of the corals and echinoderms, and many of the larger shells have been permanently mounted on bases. For this purpose pine tablets, one-half and three-quarters of an inch thick with bevelled edges, and painted pale gray, have been adopted. In the case of corals, with large or irregular bases, it has been found more convenient to form around them a tablet of the same shape and color, consisting of plaster of Paris and hydraulic cement, mixed with suitable pigments. The echinoderms and most of the mounted shells are held upright by silver-plated brass wires, variously attached according to the subject. Most of the mounting has been done very neatly and skillfully by Mr. E. H. Hawley.

During the summer vacation, as in seven previous years, the curator took charge of the dredging, carried on by the U. S. Fish Commission, and as usual the large collections of invertebrata were sent here for elaboration. Mr. Richard Rathbun and Mr. Sanderson Smith, were the principal assistants during this season. The headquarters were at Gloucester, Mass., and the explorations were to the eastward and southward of Cape Ann and in Massachusetts Bay. When fully studied, a series of these specimens will be deposited in the Museum, by the curator.

One of the most important additions received this year is a large series of British crustacea, shells, polyzoa, and sponges authentically named, and sent by the Rev. A. M. Norman, in exchange.

Mr. J. H. Emerton, Salem, Mass., presented specimens of a rare spider (*Epeira Puckardii*) from Mt. Washington.

Mr. J. C. Punderford gave a squid (*Loligo*) from New Haven.

Messrs. A. Foote & Co., New Haven, presented a seal (*Phoca vitulina*) taken at Tomlinson's Bridge, in New Haven harbor. Also a large cluster of oysters.

Mr. W. C. Beecher, New Haven, gave a hen's egg, containing a second shell, inside the outer one, and separated from it by a layer of albumen.

Mr. C. K. Mixter (S. S. S. 1877) presented insects, crustacea, and a *Gordius* from Illinois.

Prof. E. S. Morse, in behalf of the University of Tokio, Japan,

gave, in exchange, a collection of corals, shells, alcoholic mollusca, crustacea, and other marine invertebrates from the Bay of Yeddo; also a "broad tape-worm" (*Bothriocephalus latus*) from Tokio.

Prof. S. W. Johnson presented a *Mermis* dug from the earth in his garden.

Miss J. M. Harrington, New Haven, gave three species of echini from Nassau, N. P.

Prof. O. C. Marsh presented a lot of fishes and marine invertebrates from Southern California, collected by Mr. G. W. G. Hazard. Also a snake from Acapulco.

Messrs. Thompson Brothers, Morris Cove, presented a bill-fish (*Belone*) from the harbor.

Lieut. W. B. Pease, U. S. A., gave a collection of skins of mammals and birds, and a few birds' nests from Nebraska.

Capt. John H. Mortimer, New York, presented a very interesting collection of pelagic invertebrates (pteropods, *Lepas*, *Halobatis*, etc.) in alcohol.

Prof. O. D. Allen gave a "copper-head snake" (*Ancistrodon contortrix*) killed at Pine Rock, near New Haven, June 7.

Mr. W. G. Brown (S. S. S.) gave, in exchange, *Squilla empusa* and *Libinia dubia* from near New Haven.

Mr. Robert Veitch, New Haven, presented specimens of a "Japanese earth-worm" (*Perichæta*) from plant-pots in a greenhouse.

Mrs. Hume, New Haven, presented two nests of weaver birds from Bombay.

Major Todd gave a monstrous fœtal pig, said to have been taken from a "boar," New Haven.

Dr. H. Hotchkiss, New Haven, skins of ermine and squirrel from near New Haven.

Mr. Fred. Habershaw, 6 W. 48th st., New York, gave a volume, containing a general list of Diatomaceæ, written by means of an electrical pen.

Mr. S. F. Clark sent living specimens of a rare fresh-water hydroid (*Cordylophora lacustris*) from near Baltimore.

Mr. Henry Turner, Vineland, N. J., sent a lot of marine and fresh-water crustacea, leeches, etc., mostly from New Jersey.

Mr. S. W. Williston presented a lot of Amphipods, from Lake Como.

Mr. A. D. Cobb gave a holothurian (*Thyone briareus*) from West Haven.

Mr. E. H. Hawley gave a lot of insects, fresh-water shells, fishes and crustacea, from Fulton County, N. Y.

Mr. Howland Briggs sent some brook trout from Fulton Co., N. Y.

Mr. C. Jerome presented fishes and insects from Saratoga Co., N. Y.

Dr. I. P. Trimble presented specimens of Italian marble, deeply perforated and honey-combed by a sponge (*Cliona sulphurea* V.). It was taken from a vessel wrecked off Long Island in 1871.

Mr. J. B. Kirby gave a round-clam (*Venus mercenaria*) containing a large purple "pearl," from New Haven.

Mr. E. B. Wilson (S. S. S.) presented a lot of barnacles (*Balanus improvisus* and *B. eburneus*) on oysters from New Haven.

Mr. Richard Fellowes, New Haven, presented a "lady-fish" (*Albula conorhynchus*) from Newport, R. I.

Mr. F. S. Smith gave a cast skin of black snake.

Prof. J. D. Dana presented a skin of an arctic seal (*Pagomys fœtidus*) from Cumberland Gulf, received from Mr. O. T. Sherman.

Prof. O. C. Marsh deposited a mounted California sea-elephant.

Mr. W. R. Girard sent sponges from Staten Island.

Prof. W. B. Dwight, Vassar College, sent a coral (*Stylaste elegans* V.) from Ebon Island.

Small collections of insects have been received from Mr. W. ... Silliman, Mr. Morton, Mr. H. C. Kingsley, Mrs. E. A. Brow... Mr. C. W. Canfield, K. Mitsikuri (S. S. S.), E. H. Hawley, H. ... Bassett, E. T. Owen, T. A. Bostwick, A. C. Hill, F. S. Smith, ... S. Beecher, H. G. Lewis, C. H. Merriam, D. B. Lane, Misses I... Professor G. J. Brush, Professor W. H. Brewer.

Small lots of shells have been presented by Mr. Fred. ... Gorham, Chas. W. Blackman, Geo. W. Hawes, Arthur F. G... Orrin Mallory.

A number of East India corals were purchased from Mr. ... Knowlton.

Mr. J. F. Whiteaves has sent to the curator portions of ... coral (*Paragorgia Pacifica* V.) from near Vancouver Islar... description.

Prof. A. E. Verrill has deposited many rare corals, etc., ... number of rare fishes, including a skeleton of the recently ... ered *Chimæra plumbea*, from deep water off Nova Scotia ... *lected by the* U. S. Fish Commission.

ANNIVERSARY.

The Anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 25, 1878. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

CIVIL ENGINEER. (1)

DANIEL WEBSTER HERING, Ph.B. *Johnsville, Md.* On Iron Substructures for Railways and Bridges.

BACHELORS OF PHILOSOPHY. (39)

WILLIAM DAY ALLEN (Select), *Hartford.* On Chinese Immigration.

*SEYMOUR LANDON ALVORD (Select), *West Winsted.* On Tramps.

*JOHN POMEROY BARTLETT (Select), *New Britain.* On the Mohammedans in Spain.

*JOHN LUIS BLACKMORE (Civil Engineering), *City of Mexico, Mexico.* On the Sewerage System of Providence, R. I.

EDWARD EVERETT BREWSTER (Chemistry), *West Cornwall.* On the Determination of Lead in Ores.

FAYETTE WILLIAMS BROWN (Select), *Yonkers, N. Y.* On the Coinage of the United States.

WILLIAM TYLER BROWNE (Biology), *Lisbon.* The Nervous System of Bufo Americanus compared with that of Rana Palustris.

LUCIEN LOWBER BURROWS (Select), *Decatur, Ill.* On Banking in the Western States.

CHARLES WILLIAM CANFIELD (Biology), *Hartford.* On the Heart of Cistudo Virginea.

ROBERT WILLIAMS CHAPIN (Civil Engineering), *Springfield, Mass.* On the Harlem Railroad, between 42d st. and 133d st., New York City.

*WILLIAM GROVER CHAPIN (Dynamic Engineering), *Somers.* On the Pumping Machinery of the New Haven Water Company.

*CHARLES SAMUEL CHURCHILL (Civil Engineering), *New Haven.* A Comparison of the Different Methods of Leveling.

*WALTER LINSLEY COWLES (Civil Engineering), *Wallingford.* A Review of the Gilbert Elevated Railway.

AUGUSTUS JAMES EMERY (Dynamic Engineering), *Bangor, Me.* On Magneto-Electricity.

GRANGER FARWELL (Select), *Chicago, Ill.* On the Origin and Characteristics of Euphuism.

*OSWIN HART DOOLITTLE FOWLER (Select), *North Haven.* On the Character of Richard the Third.

CADMUS ZACCHEUS GORDON (Select), *Brookville, Pa.* On Adams and Jefferson.

LEONARD VASSALL GREENE (Agricultural), *Norwich.* On Tea; its Cultivation at home and abroad.

RALPH AUGUSTUS HARMAN (Civil Engineering), *Cleveland, O.* On the Superior Street Viaduct, Cleveland, O.

WALTER TILLMAN HART (Select), *New Haven.* On the Newfoundland Fisheries.

GEORGE STEWART HEGEMAN (Select), *Brooklyn, N. Y.* On Heredity, Physiologically and Psychologically Considered.

CHARLES BETTS HILLHOUSE (Select), *New Haven.* On the Power of the House of Commons over the Public Purse.

ROBERT SAMUEL HULBERT (Civil Engineering), *West Winsted.* On a Method of Determining Time and Latitude by the Engineer's Transit.

THOMAS MASTIN JACKS (Chemistry), *Helena, Ark.* On the Chemical Reaction Involved in Gold and Silver Assaying.

FRED. BECKWITH JILLSON (Agricultural), *Whitehall, N. Y.* On Irrigation.

EDWARD CHARLESS LEBOURGEOIS (Dynamic Engineering), *St. James Parish, La* A Mechanical View of Sugar Manufacture.

GEORGE WEBB MASON (Select), *Orange, N. J.* On the Development of Modern Musical Instruments.

WILLIAM JAMES PERRY MOORE (Dynamic Engineering), *New Britain.* On Cable-Making as Applied to the Brooklyn Bridge.

FRANK TURNER MOORHEAD (Select), *Pittsburgh, Pa.* On Gold; its Mining and Uses.

GEORGE HENRY POTTS (Select), *Pittstown, N. J.* On Constitutional Reform in the New England States.

EDWARD TOWNSEND REED (Select), *Albany, N. Y.* On the History of the National Debt of the United States.

CHARLES THEODORE RICHMOND (Select), *Johnsonville, N. Y.* On the Cotton Manufacture.

EDWARD KILBOURN ROBERTS (Select), *New Haven.* On the History of the Labor War, and its Effects upon Employers and Employed.

EDWARD HUBBARD RUSSELL (Dynamic Engineering), *New Haven.* On the Strength of Iron and Steel with reference to Bridge Construction.

EDWARD HERNDON SMITH (Chemistry), *Brooklyn, N. Y.* On the Separation of Iron from Manganese.

WILLIAM ANNIN VLIET (Select), *Cleveland, O.* On the Diplomatic and Consular System of the United States.

EBIN JENNINGS WARD (Civil Engineering), *Marseilles, Ill.* On the Proposed Illinois Ship Canal.

* EDMUND BEECHER WILSON (Natural History), *Geneva, Ill.* Monograph on the New England Pycnogonidæ.

* FRANCIS DANA WINSLOW (Select), *Washington, D. C.* On the Method of Electing the President of the United States.

PRIZES.

The following prizes were announced at this anniversary:

CLASS OF 1878.

For Excellence in German, the prize awarded to JOHN P. BARTLETT, *New Britain.*

For Excellence in French, the prize awarded to EDWARD H. SMITH, *Brooklyn, N. Y.*

For Excellence in Civil Engineering, the prize awarded to WALTER L. COWLES, *Wallingford.*

CLASS OF 1879.

For Excellence in the Mathematics of Junior Year, the prize awarded to GEORGE A. SAUNDERS, *Newport, R. I.*, with honorable mention of CHARLES A. WILCOX, *Painesville, O.*

For Excellence in Chemistry, the prize awarded to WILLIAM J. COMSTOCK, *Toledo, O.*, with honorable mention of JOHN JEWETT, *Brooklyn, N. Y.*

For Excellence in Mineralogy, the prize awarded to FREDERICK I. ALLEN, *Auburn, N. Y.*

CLASS OF 1880.

For Excellence in all the Studies of Freshman Year, DWIGHT PORTER, *Hartford.*

For Excellence in German, the prize divided between ERNEST T. LIEFELD, *New Haven*, and DWIGHT PORTER, *Hartford.*

For Excellence in Mathematics, the prize awarded to DWIGHT PORTER, *Hartford.*

For Excellence in Physics, the prize awarded to DWIGHT PORTER, *Hartford.*

For Excellence in Mechanical Drawing, the prize awarded to GEORGE ROBERT FERGUSON, *New Haven.*

CLASS OF 1881.

For the best Entrance Examination, the prize awarded to ETHAN ALLEN ANDREWS, *Tarrytown, N. Y.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1878-79.

CALENDAR.

1878.		
12 Sept.	Thursday,	First Term begins.
19 Dec.	Thursday,	First Term ends.
		Winter Vacation of three weeks.
1879.		
9 Jan.	Thursday,	Second Term begins.
9 April,	Wednesday,	Spring Recess begins.
16 April,	Wednesday,	Spring Recess ends.
24 June,	Tuesday,	Meeting of Appointing Board.
24 June,	Tuesday,	Anniversary.
26 June,	Thursday,	Commencement.
27 June,	Friday,	Examination for Admission.
28 June,	Saturday,	
		Summer Vacation of eleven weeks.
9, 10 Sept.	Tues., Wedn.,	Examination for Admission.
11 Sept.	Thursday,	First Term begins.
18 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

CORPORATION.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY RICHARD D. HUBBARD, LL.D., HARTFORD.
HIS HONOR FRANCIS B. LOOMIS, NEW LONDON.
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FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

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REV. NOAH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering. (34 N. S. H.) 72 Prospect st.

CHESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

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GEORGE J. BRUSH,
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Theoretical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

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Agriculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

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Mathematics. 29 Eld st.

DANIEL C. EATON,
Botany. (14 N. S. H.) 70 Sachem st.

THOMAS R. LOUNSBURY,
English. (6 S. H.) 22 Lincoln st.

OTHNIEL C. MARSH,
Palæontology. (8 P. M.) New Haven Hotel.

FRANCIS A. WALKER,
Political Economy and History. (40 N. S. H.) 68 Whitney av.

OSCAR D. ALLEN,
Analytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (15 P. M.) 148 College st.

SIDNEY I. SMITH,
Comparative Anatomy. (14 P. M.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 8 Trumbull st.

A. JAY DU BOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

LECTURERS, INSTRUCTORS AND ASSISTANTS.

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 27 Eld st.

MARK BAILEY,
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JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

OSCAR HARGER,
Palæontology. (9 P. M.) 14 University pl.

JOSEPH J. SKINNER,
Mathematics. 28 Eld st.

AUGUST H. EDGREN,
French. 73 York st.

GEORGE W. HAWES,
Mineralogy. (2 P. M.) 116 High st.

JOSEPH F. KLEIN,
Kinematics and Machine Design. (45 N. S. H.) 86 Nicoll st.

EDMUND B. WILSON,
Zoölogy, 523 Chapel st.

WALTER WATSON,
Surveying. 90 Grove st.

SAMUEL L. PENFIELD,
Analytical Chemistry. 14 S. H.

WILLIAM T. SEDGWICK,
Physiological Chemistry. (13 S. H.) 14 S. H.

GRADUATE STUDENTS.

William Whittlesey Abbott, PH.B.,	*Worcester, Mass.*	257 Church st.
Frank Dawson Adams, B.S., McGill University.	*Montreal,*	26 Trumbull st.
Henry Prentiss Armsby, PH.B.,	*New Haven,*	206 York st.
John Pomeroy Bartlett, PH.B.,	*New Britain,*	16 S. H.
John Luis Blackmore, PH.B.,	*City of Mexico, Mexico,*	40 Park st.
Thomas Marcus Blakslee, PH.B., Madison University.	*Hamilton, N. Y.*	14 Compton st.
Walter Linsley Cowles, PH.B.,	*Wallingford,*	Wallingford.
Frederic Henry Crafts, M.A., Dartmouth College.	*Uncasville,*	35 High st.
Frederic Perkins Dewey, PH.B.,	*Hartford,*	87 Olive st.
William Ely, PH.B., Brown University.	*Providence, R. I.*	35 Hillhouse av.
Augustus James Emery, PH.B.,	*Bangor, Me.*	675 Chapel st.
Edward Hopkins Jenkins, B.A.,	*New Haven,*	206 York st.
Joseph Frederick Klein, D.E.,	*New Haven,*	86 Nichols st.
Arthur Lakes, B.A., Oxford University, England.	*Golden, Col.*	92 High st.
Nawokichi Matsui, PH.B., Columbia College.	*Tokio, Japan,*	59 Wall st.
James Boyd Neal, B.A.,	*Bloomsburg, Pa.*	6 Library st.
Samuel Lewis Penfield, PH.B.,	*Catskill, N. Y.*	14 S. H.
Richard Rathbun, Cornell University.	*Buffalo, N. Y.*	N. S. H.
Alfred Lawrence Ripley, B.A.,	*Andover, Mass.*	123 W.
Edward Hubbard Russell, PH.B.,	*New Haven,*	19 Wooster pl.
William Thompson Sedgwick, PH.B.,	*Farmington,*	14 S. H.
Benjamin Thaw, B.A., Western Univ. of Pa.	*Pittsburgh, Pa.*	171 Crown st.
John Trumbull, B.A.,	*Valparaiso, Chili,*	124 High st.
Horace Lemuel Wells, PH.B.,	*New Britain,*	47 N. S. H.
Samuel W. Williston, B.B., Kansas Agric. College.	*Manhattan, Kan.*	92 High st.
Edmund Beecher Wilson, PH.B.,	*Geneva, Ill.*	523 Chapel st.

GRADUATES, 26.

SENIOR CLASS.

derick Innis Allen,	*Auburn, N. Y.*	33 Prospect st.
rry Washington Asher,	*New Haven,*	6 Orange st.
lliam Montgomery Atwater,	*New Haven,*	161 George st.
thaniel Terry Bacon,	*Norwich,*	247 Church st.
nuel Eben Barney,	*New Haven,*	110 Olive st.
rge Frederick Hunter Bartlett,	*Buffalo, N. Y.*	156 York st.
eph Bidleman Bissell,	*Lakeville,*	156 York st.
lcom Booth,	*South Kingston, R. I.*	17 Wooster pl.
lliam James Comstock,	*Toledo, O.*	37 College st.
ert William Congdon,	*Brooklyn, N. Y.*	120 Crown st.
n Howard Cromwell,	*Cranford, N. J.*	156 York st.
rles Thompson Dodd,	*West Meriden,*	156 York st.
hur Dodge,	*Stamford,*	156 York st.
rge Clarence Egan,	*Chicago, Ill.*	36 Elm st.
erson Young Foote,	*New Haven,*	156 York st.
rman Norton Fowler,	*Agawam, Mass.*	147 York st.
n Currier Gallagher,	*New Haven,*	21 Olive st.
athan Godfrey,	*Southport,*	156 York st.
nk Hanson Harrison,	*Indianapolis, Ind.*	117 w.
ald Waldo Hart,	*New Britain,*	33 Prospect st.
rry Dudley Hibbard,	*Woodside, N. Y.*	134 College st.
nk Hillhouse,	*New Haven,*	3 Hillhouse av.
rles DeVilliers Hoard,	*Chicago, Ill.*	122 York st.
rles Perry Hull,	*Lebanon,*	128 High st.
n Jewett,	*New York City,*	131 Temple st.
derick Augustus Jones,	*Newark, N. J.*	156 York st.
red Dennis Lewis,	*Bridgeport,*	156 York st.
rge Walker Meeker,	*Chicago, Ill.*	131 Temple st.
kichi Mitsukuri,	*Tokio, Japan,*	130 York st.
ward Delavan Nelson,	*New York City,*	55 Trumbull st.
lter Nordhoff,	*Alpine, N. J.*	73 w.
derick Wallace Paramore,	*St. Louis, Mo.*	36 Elm st.
bert Wilson Patrick,	*Omaha, Nebr.*	79 York st.
rold Roorbach,	*New York City,*	104 Grove st.
rge Augustus Saunders,	*Newport, R. I.*	187 Temple st.
lliam Seth Silsby,	*Seneca Falls, N. Y.*	36 Elm st.
fus Henry Skeel,	*Newburgh, N. Y.*	156 York st.
rbert Eugene Smith,	*Hartford,*	187 Temple st.
ddeus Henry Spencer,	*Suffield,*	147 York st.
iah Kidder Stetson,	*Bangor, Me.*	156 York st.
iel Eddie Stone,	*Cleveland, O.*	136 Crown st.
hur Stoddard Van Voorhis,	*New York City,*	55 Trumbull st.
n Thomas Waring,	*Yonkers, N. Y.*	136 Crown st.
rt Lowery Webster,	*Staten Island, N. Y.*	86 w.
les Seward Wilcox,	*Painesville, O.*	145 York st.
ter Smith Williams,	*Evanston, Ill.*	36 Elm st.

SENIORS, 46.

JUNIOR CLASS.

Daniel Sidney Appleton,	*New York City,*	55 Trumbull
Charles Ketchum Averill,	*Bridgeport,*	128 High
Charles Rufus Ayres,	*Woodmont,*	156 York
Charles Backus Ball,	*New Britain,*	32 Mansfield
Rogers Clark Ballard,	*Louisville, Ky.*	132 College
Edward Hallaran Booth,	*New Orleans, La.*	25 Prospect
Harry Banning Bradford,	*Wilmington, Del.*	6
Harry Osborn Carrington,	*New Haven,*	527 Chapel
Joseph Arthur Chanute,	*New York City,*	5
George Huntington Clark,	*Norwich,*	19 Trumbull
Arthur Baylies Coffin,	*Edgartown, Mass.*	167 Temple
Edward Allen Colby,	*St. Johnsbury, Vt.*	7 Library
Frank McAlpine Collin,	*Penn Yan, N. Y.*	27 Prospect
Charles Mabie Crouse,	*Syracuse, N. Y.*	36 Elm
Thomas Edward Doolittle,	*Onarga, Ill.*	36 Elm
Jacob Edward Emery,	*Fair Haven,*	17 Crown
William Henry Fox,	*Washington, D. C.*	25 Prospect
George Edward Goodspeed,	*East Haddam,*	22 Trumbull
John Warren Hardenbergh,	*Jersey City, N. J.*	66
Samuel Higgins,	*Buffalo, N. Y.*	134 College st.
Louis Maynard Higginson,	*Newburgh, N. Y.*	61 w.
Walter Hitchcock,	*Cheshire,*	19 Trumbull st.
Theodore Lanahan Hooper,	*Baltimore, Md.*	169 Temple st.
Colin Macrae Ingersoll,	*New Haven,*	85 Trumbull st.
Martin Edward Jensen,	*Cleveland, O.*	64 High st.
David Brown Lewis,	*Utica, N. Y.*	86 w.
Ernest Theophilus Liefeld,	*New Haven,*	36 Orchard st.
Richard Becker Lyon,	*New Haven,*	710 Chapel st.
Willey Solon McCrea,	*Chicago, Ill.*	36 Elm st.
John Moorhead,	*Pittsburgh, Pa.*	165 Temple st.
Carl Eugene Munger,	*Watertown,*	27 Prospect st.
Edward Butler Needham,	*Hartford,*	36 Elm st.
Frederic Adriance Osborn,	*New Haven,*	150 York st.
George Benjamin Phelps, Jr.,	*Watertown, N. Y.*	36 Elm st.
Dwight Porter,	*Hartford,*	14 Lock st.
Edgar Sheffield Porter,	*New Haven,*	38 Hillhouse av.
Edward Freeman Porter,	*Stowe, Vt.*	23 Prospect st.
Edward Vilette Reynolds,	*Chicago, Ill.*	104 Grove st.
Edwin McNeil Rogers,	*Central City, Col.*	58 w.
George Bliss Rogers,	*Lexington, Mass.*	36 Elm st.
Isaac Marion Rosenthal,	*Rochester, N. Y.*	35 Howe st.
Edward Rupert Sargent,	*New Haven,*	51 Elm st.
William Bartlett Schofield,	*West Point, N. Y.*	48 College st.
Henry Starkweather,	*New Haven,*	178 Oak st.
Elliott Joseph Stoddard,	*Seymour,*	52 Whalley av.

owe Wadsworth.	*Farmington,*	165 Temple st.
Landee Warren,	*Buffalo, N. Y.*	61 w.
rederic Wehner,	*New Haven,*	544 Chapel st
oodwin Williams,	*Glastonbury,*	60 w.
urnham Woodford,	*West Winsted,*	116 College st.

JUNIORS, 50.

FRESHMAN CLASS.

rancis Adams,	*Jessups, Md.*	87 Olive st.
len Andrews,	*Tarrytown, N. Y.*	Elm st.
ackson Angell,	*Brooklyn, N. Y.*	167 Temple st.
Bailey,	*Harrisburgh, Pa.*	432 Chapel st.
ean Bevan,	*Chicago, Ill.*	43 College st.
wis Bigelow,	*New Haven,*	278 Orange st.
rederick Bosworth,	*Milford,*	518 State st.
Perry Bradley,	*Westville,*	Elm st., Westville.
ıige Breckenridge,	*Westfield, Mass.*	114 High st.
heldon Burnham,	*Woodbridge,*	29 Prospect st.
lonroe Carpenter, Jr.,	*Brooklyn, N. Y.*	123 Park st.
Casper,	*West Meriden,*	14 Olive st.
hamberlain.	*Brooklyn, N. Y.*	167 Temple st.
Field Chappell,	*Chicago, Ill.*	43 College st.
trong Daniels.	*New York City.*	64 High st.
rague Davidson.	*San Francisco, Cal.*	432 Chapel st.
ereux.	*Cleveland, O.*	257 Church st.
lanville Downs,	*New Haven.*	92 Greene st.
inchester Dye,	*New Haven,*	194 Prospect st.
le Ely,	*New York City,*	59 w.
herman Folsom,	*Northford,*	161 George st.
Francis Fnsick,	*Hartford,*	99 Wall st.
oses Gerstle,	*Youngstown, O.*	6 Orange st.
reighton Giles.	*Southport,*	84 Wall st.
olbrook Gladding,	*New Haven,*	90 Dwight st.
Leeds Goodsell,	*New Haven,*	6 High st.
Loomis Griswold,	*Banksville,*	127 Whalley av.
Jonathan Hiller,	*Cohoes, N. Y.*	59 w.
ugustus Hotchkiss,	*New Haven,*	69 York st.
lison Hubbard,	*Sandusky, O.*	123 Park st.
nison,	*New Orleans, La.*	165 Temple st.
Fowler Jarvis, Jr.,	*New York City,*	132 College st.
n Yow,	*Canton, China,*	136 College st.
iphalet Killam,	*New Haven,*	67 Wooster st.
Parker Lord,	*Saxonville, Mass.*	134 College st.
l White Lynde,	*West Brookfield, Mass.*	87 Olive st.
zger,	*New Haven,*	17 Grove st.

Edwin Kirtland Morse,	*Poland, O.*	
Marcus Daty Munn,	*Southington,*	127 Whal
Marvin Olcott,	*Corning, N. Y.*	134 Coll
Owyang Keng.	*Canton, China,*	136 Coll
Francis Stuyvesant Peabody,	*Chicago, Ill.*	84 W
Oliver Phelps,	*Canandaigua, N. Y.*	123 P
Harry Smith Pope,	*Jersey City, N. J.*	196 Cro
Joel Howard Reed,	*Albany, N. Y.*	55 Trumb
Addison Alexander Righter,	*Newark, N. J.*	8 L
John Hutchinson Robinson,	*Lake Village, Ark.*	126 Cro
George Lewis Sargent,	*New Haven,*	51 I
Joseph Denny Sargent,	*New Haven,*	51 I
Louis Jacob Schiller,	*New Haven,*	8 Mai
Bernard Joseph Shanley.	*New Haven,*	211 Franl
Frank Augustus Smith,	*New Haven,*	36 Ly
George Edward Stevens,	*New Haven,*	7 Woos
Henry Taber,	*New York City,*	140 Edwa
Burton Henry Todd,	*Wallingford,*	22 Trumb
John Heyward Trumbull,	*Talcahuana, Chili,*	13 Trumb
Richard Lindsay Trumbull,	*Talcahuana, Chili,*	13 Trumb
John Henry Ullrich,	*Decatur, Ill.*	c. Davenport av. A
Howard VanRensselaer.	*Albany, N. Y.*	23 Prosp
Frank Charles Warner,	*West Suffield,*	305 Oran
Robert William Watson,	*Ashtabula, O.*	257 Chu
Harry Yale Witbeck,	*Chicago, Ill.*	84 W
William Meeker Wood,	*Morristown, N. J.*	191 Tem
Willis Benton Wright,	*Cromwell,*	88 Gro

FRESHMEN, 6

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Norton Bail,	*New Haven,*	43 Pe
Robert Batcheller,	*Boston, Mass.*	68 Whitn
William Henry Chappell,	*Chicago, Ill.*	43 Colle
Frederick Burr Clemmons,	*New Haven,*	162 Putn
Peter Franklin Conway,	*New Haven,*	117 Washingt
Edgar Bertrand Doolittle,	*Cheshire,*	22 Trumb
Joseph Caldwell Earle,	*New Haven,*	214 Orcha
Henry Arthur Smith,	*Honesdale, Pa.*	29 Hi
Schuyler Van Vechten,	*Albany, N. Y.*	55 Trumb
Walter Watson,	*Northampton, Mass.*	90 Gro
Charles Wilcoxson Whittlesey.	*New Haven,*	524 Cha

SPECIAL STUDENTS, 1

SUMMARY.

Graduates. - - - - -	26
Seniors, - - - - -	46
Juniors, - - - - -	50
Freshmen, - - - - -	64
Special, - - - - -	11
Total, - - - -	197

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts *for Connecticut.*" Since that time, and *especially since the autumn of* 1869, numerous liberal gifts have

been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDING AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoology and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of *Cambridge*, a meridian circle, etc.
6. *A Collection of* Mechanical Apparatus, constituting the "Collier Cabinet."

7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given *by the graduate* instructors in other departments

of the University. This degree is conferred upon those who, hav ing already taken a Bachelor's degree, engage as students in th Department of Philosophy and the Arts for not less than tw years in assiduous and successful study. It is not given upon ex amination to those whose studies are pursued elsewhere. The re quirements for it will in some cases exact of the student more tha two years of post-graduate labor; so, especially, wherever th course of undergraduate study has been, as in the Scientific Schoo of less than four years. The candidate must pass a satisfactor final examination, and present a thesis giving evidence of hig attainment in the branches of knowledge to which he has attended A good knowledge of Latin, German and French will be require in all cases, unless, for some exceptional reason, the candidate b excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested a follows:—

Professor NORTON will instruct in applied mechanics and i spherical astronomy.

Professor LYMAN, in the use of meridional and other astronom cal instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, an utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of miner species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultura chemistry.

Professor BREWER, in agriculture and forest culture, in the us of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equation analytical mechanics, the theory of numerical approximation and the method of least squares.

Professor EATON, in structural and systematic botany, includin the North American flora and the description of genera an species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geol- *ogy.*

The same courses of study are open, for a longer or shorter time,

to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor *of Dynamic* Engineering, and under such *circumstances as shall appear to* him to be favorable to profes*sional progress.*

An elaborate thesis on some professional subject, with an ori inal design, or project, accompanied by proper working drawing will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being ful qualified, desire to pursue particular studies without reference the obtaining of a degree, special or irregular students are receiv in most of the departments of the School; not, however, in t Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities a not offered to persons who are incompetent to go on with regul courses, but are designed to aid those who, having received a suf cient preliminary education elsewhere, desire to increase their pr ficiency in special branches.

VII.

REQUIREMENTS FOR ADMISSION AND COURSES O INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less th fifteen years of age, and must bring satisfactory testimonials moral character from their former instructors or other responsib persons.

For admission to the Freshman Class the student must pass thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney' Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exe cises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theo of equations.

Geometry—Plane, solid and spherical; including fundamental notions of sym metry, and examples of loci and of maxima and minima of plane figures:- an equivalent of the nine books of Chauvenet's Treatise, or to the ten book of Loomis's Elements and the Appendix, up to the section on Tranversals.

Trigonometry—including the analytical theory of the trigonometrical function and the usual formulæ; the construction and use of trigonometrical table and the solution of plane triangles;—so much, for example, as is contain *in Wheeler's* Plane Trigonometry (Boston, 1877), or Richards's Plane Tri *nometry* (New York, 1878).

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive officer of the School, on or before June 15.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of Logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat, orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant, merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the requirement, the following works are specifically named, among which the candidate for examination may make his own selection. These are Harkness' "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part 1; or McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not *required*.

The examinations for admission take place at North Sheffie Hall, on Friday and Saturday, June 27, 28, and on Tuesday a Wednesday, September 9, 10, 1879. Opportunities for priva examinations may, in exceptional cases, be given at other tim

In 1879, examinations, for the Freshman Class only, will also held in Chicago and in Cincinnati (beginning on Friday, June at 9 A. M.), at a place to be announced in the local newspapers the day previous.

Candidates for advanced standing in the undergraduate clas are examined, in addition to the preparatory studies, in th already pursued by the class they wish to enter. No one c be admitted as a candidate for a degree, later than at the beg ning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, a arranged to suit the requirements of various classes of studen The first year's work is the same for all; for the last t years the instruction is chiefly arranged in special courses. T special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annex scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Hadl Brief History of the English Language; Exercises in Composition. *Mathema* —Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectu *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Pract Lessons in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Ma matics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Phys Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Econ* —Elementary Lectures. *Drawing*—Elementary Projection Drawing; Isome Drawing; Descriptive Geometry commenced.

For the Junior and Senior years the students select for the *selves* one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry.* Lectures. *Qualitative Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice.* Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Agricultural Chemistry*—Recitations and Lectures (optional). *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs commenced. Stone Cutting—with graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechaniam. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing. General Theory of Motion, and Principles of Mechanism. *German. French.*

SENIOR YEAR:

FIRST TERM—Principles of Mechanism. Applications of the Princip Mechanism to Machinery. Machine Construction. Blowpipe Analysis.] ance of Materials. Construction of roof trusses, girders, and iron b Machine Drawing. *Geology. French.*

SECOND TERM—General principles of Heat employed as a source of] The construction of Steam Generators. Steam Engines. Hot Air E Water Engines. Water Wheels. The Construction of Water Reservoir Conduits. Measurement of Water Supply. Discharge of Pipes, etc. Gra Statics. Machine Designing. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM — *Theoretical and Organic Chemistry* — Lectures. *Qual Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. I*

SECOND TERM — *Laboratory Practice*—Quantitative Analysis. *Minera* Blowpipe Analysis and Determination of Species. *Physical Geography*—Le *Botany*—Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the No States. Tree Planting and Forestry. *Agricultural Chemistry* — John *Physiology*—Huxley's. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Bre Lectures. *Geology* — Dana's. *Rural Economy* — History of Agricultur Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *A tural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Micro English. French.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the pri study, some attention in each case being directed to the other three branc Natural History.

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis. Laboratory Practice. R tions. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *E* —Gray's Manual; Use of the Microscope. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice. Excursions (land and ma *Botany*—Laboratory Practice. Thomé's Text-book. Excursions. *Mineral* continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory Pra *Lectures. Excursions. Botany*—Herbarium Studies. Excursions. *Phys* —*Huxley's. French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice. Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders. Botanical Literature. Essays in Descriptive Botany. *Meteorology*. *French*.

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

During the Junior year, the work of this course is chiefly under the direction of the instructors in Chemistry. Especial attention is given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In Toxicology the organic and mineral poisons are carefully studied. The special studies of the Senior year are wholly biological, particular attention being paid to the elements of comparative anatomy, histology, and physiology, to structural and physiological botany, and to systematic zoology. Instruction is also given in embryology, the laws of heredity, and human parasites. The order of studies is as follows:

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis—Fresenius'. Laboratory Practice. Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM—*Physiological Chemistry*—Klein's Handbook. *Toxicology*—Fresenius'. Laboratory Practice. Recitations. Lectures. *Botany* — Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *Mineralogy*—continued. *German*. *French*.

SENIOR YEAR:

FIRST TERM — *Comparative Anatomy and Histology* — Laboratory Practice. *Physiology*—Huxley's, with Practical Exercises. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—Dana's Manual. *Zoology*—Lectures and Excursions. *French*.

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Botany* — Lectures. Laboratory Practice in Cryptogamia, etc. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French*.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study *of metallurgical chemistry*, mineralogy, etc.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot. Lectures. *Botany*—Lectures and Excursions and Laboratory Practice. *English*—Chaucer, Bacon, Shakespeare. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakespeare. *History*—Constitutional History of the United States. Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English*—Shakespeare, Milton, Dryden, Pope, and later authors. *History*—Political History of United States. History of Europe from 18—48. Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. *By this method* all the problems in Descriptive Geometry are *required to be* worked out on the drawing-board instead of the

black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why *particular specimens belong* to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity Church (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the *Governing Board*, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 17–18.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 11, 1879. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 24th, 1879, and at or about the same time in the year 1880, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the *Appointing Board.*

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

FOURTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1879-80.

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1880.

State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOAR FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Excellency CHARLES B. ANDREWS, Litchfield.

LIEUTENANT-GOVERNOR.

His Honor DAVID GALLUP, Plainfield.

STATE SENATORS.

Hon. G. W. PHILLIPS, Putnam.
Hon. LYMAN W. COE, Wolcottville.
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REPORT

OF THE

STATE BOARD OF VISITORS.

o the General Assembly:

The State Board of Visitors of the Sheffield Scientific School erewith transmit the Annual Report of the Governing Board : that institution. This report, very full in details, will fur- ish all the particular information needed, and will also show ie great usefulness of the educational work which the school doing.

The greatly increasing interest in the study of the natural iences, as well as the increasing disposition to pursue the igher technical parts of many branches of study, show that iis school has done much to develop and to supply a most seful and important field of mental activity. The people of ew England will never be likely to forget that there is a iaterial value in education,—nor ought they to forget that the igher the education the more sure it is to bring returns of a ecuniary kind. In this respect the Scientific School is of reat value. One or two illustrations will make this apparent.

The Agricultural Experiment Station and the instruction in chemistry, *botany, geology, mineralogy* and the allied sciences,

gives to the farmer that specific learning by which farming is made successful and profitable. Instruction in Mechanical Engineering promotes and sharpens the inventive faculty—the faculty in which more than in any other Connecticut finds its material comfort and wealth. Many other examples will readily be suggested by an examination of the course of studies taught in this school.

We again call attention to the thirty free scholarships in the school which can be had for the asking. That there is not more competition for them is not creditable to the educational spirit of our young men.

By Order of the Board.

CHARLES B. ANDREWS,

Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Fourteenth Annual Report, the Governing Board wish to call attention to the instruction in Civil Engineering as carried on in the Sheffield Scientific School. With the reviving prosperity of the country this subject is beginning to assume once more the importance which belonged to it, before the general depression in business had brought about the cessation of any new enterprises demanding the services of a trained body of specialists. Under these circumstances, therefore, the Governing Board have deemed it expedient to give a brief account of the course in Civil Engineering as pursued here, and of the methods adopted to secure the results aimed at.

Course in Civil Engineering.

This Department was organized in the year 1852, under the title of the Yale School of Engineering, and under the direction of a Professor of Civil Engineering. The number of students in attendance, annually, since the date of organization, has varied from 15 to 50. At the opening of the School in 1852, there were but three other schools of Engineering in the United States. The number has since largely increased, and most of our Colleges and Universities have instituted Departments of Engineering; and yet, as a striking evidence of the important position this School of Engineering has occupied, it may be stated that, except seasons of business depression, the number of students connected with it has generally increased from year to year—the maximum number having been reached in 1873. Periods of general depression in business, and especially in engineering enterprises, have had a marked influence on the size of our classes. The *depression of 1857 was* very sensibly felt; and that of the

last few years has exercised a similar influence in this and all other departments of the Scientific School. We may reasonably expect that the revival of business activity, which has now begun, and especially of engineering operations, will materially increase the number of applicants for our course of Civil Engineering. But to reap the best results from the returning tide of prosperity, care must be taken that the strength and efficiency of the department be fully maintained, and that the advantages which have hitherto been held out be not diminished, but, on the contrary, augmented. This is rendered the more imperative by the largely increased provision that has been made for instruction in Engineering in other Institutions, and the ampler endowment of which other similar schools are now reaping the advantage. The general success of our graduates, and the evidence they have usually given of thoroughness of scientific attainment, and facility and accuracy in the use of field-instruments and in drawing, has been one prominent cause of the success of the department; and is the best evidence that the course of instruction is well adapted to secure the end desired. The graduates from the department have found occupation in many different lines of engineering practice. Several have been, for a number of years, assistants in the Coast Survey; others have done good service in the Western topographical surveys; many have engaged in general surveying and engineering, and a few in hydraulic engineering; some have become architects, after pursuing a special preparatory course; and others scientific instructors, or professors of engineering; but the larger number have engaged in railroad engineering, and found occupation in connection with the location, construction, or operation of railroads. In the year 1870 a separate department of Dynamic, or Mechanical Engineering was instituted, and a professor of dynamic engineering appointed. Since that date there have been separate classes, pursuing for the most part distinct courses of study, in Civil and Dynamic Engineering.

COURSE OF INSTRUCTION.

The field of practical Civil Engineering is of very wide extent; comprising various departments of construction, and the maintenance of existing structures, with the preliminary operations of *location*, and the different branches of surveying. The course of *engineering* is accordingly designed to fit the student to enter

upon any of these several lines of professional practice. To do this effectually it must be a suitable combination of scientific theory with practical applications and field and office practice. It accordingly comprises a course of scientific studies, and another of practical exercises. The course of study need not here be detailed. The student starts from the vantage ground of a knowledge of the elementary Mathematics, and during the first two years is carried over the higher Mathematics, and theoretical Mechanics. He is thus fitted to take up in the third year the applications of mathematics and mechanics to the different departments of the science of construction. For reasons that will no doubt be sufficiently obvious, other studies not of a mathematical character are pursued, as Chemistry, Mineralogy and Geology; and the French and German languages occupy a certain portion of the allotted time. For the course of Geometrical Drawing the scientific foundation is laid in a knowledge of Descriptive Geometry; Graphical Statics and Constructional Drawing occupy a part of the Senior year. Practical Surveying comprises, besides the ordinary field operations with the compass and theodolite, and leveling, Topographical Surveying, with the use of the plane table, and the construction of topographical charts.

It is not supposed that a student who has completed the three years course, and taken the degree of Ph.B., is fitted to enter on the profession of Civil Engineering, and competent to take charge of engineering enterprises. The endorsement implied in the degree of C.E. is not given until after an additional year of higher study combined with practice in astronomical observation, and the designing of structures, and after a year or more of practical experience in responsible positions in the field.

APPARATUS AND INSTRUMENTS.

The department is supplied with a large collection of models and other illustrative apparatus, and with a complete set of instruments for practical surveying and field engineering. The models are of wood or plaster, and were imported from France and Germany. Many of them are designed to illustrate problems in Descriptive Geometry, and in Constructional Drawing. The collection also comprises numerous models, in plaster, of arches, spiral staircases, &c., and architectural models. The set of models and apparatus is by no means complete. There is need of additional *models of bridges, roofs*, &c., and especially of

details of structures, and of testing machines. The only experimental apparatus on hand is a testing machine of moderate dimensions and limited application. This has proved very serviceable, and might, to great advantage, be supplemented by others of larger dimensions, and different adaptations.

Agricultural Experiment Station.

The Connecticut Agricultural Experiment Station has still the free and exclusive use of the first story of the eastern wing of Sheffield Hall, and as heretofore, the facilities of laboratory apparatus, and the materials of the school have also been used by the station when needed.

The New Haven Farmers' Club has had the free use of a room for its meetings, which are held on the first and third Fridays of the month for half the year, and on the first Friday of each month during the Summer. The New Haven County Agricultural Society has had the free use of rooms for its business meetings. In various other ways the school has, according to its opportunities, given such aid and assistance as it could to the farming and and gardening interests of the State.

Horological Bureau of Yale College.

The recent establishment of the Horological Bureau of the Winchester Observatory on the premises of the School affords, incidentally, increased advantages to students in Practical Astronomy, and although the Bureau does not belong to the School, it is in many ways so closely connected with its interests and work that some account of it seems appropriate in this report.

This Bureau is a department of the Winchester Observatory, and has been organized by the Board of Managers of the Observatory under the authority of the Corporation of Yale College, by whom the property of the Observatory is held. Dr. Leonard Waldo has been appointed the Astronomer in charge of the Bureau, and has the immediate direction of its affairs.

The work of the Bureau is twofold; first, to distribute by telegraph exact time-signals to cities, towns, railroads, factories, banks, jeweler's shops and other places, as may be required, for the purpose of securing correct and uniform time throughout a wide region; and secondly, to promote the growing and important industry of the clock and watch manufacture in this country by ample provision for the careful testing of time-pieces, as is

done by several government observatories in behalf of the same industry abroad. This service, now introduced for the first time in this country, is explained in detail in the circular issued by the Bureau, which is printed at the end of this notice.

The standard of time adopted by the Bureau, (as well as by the College and the City of New Haven, and marked by the telegraphic time-signals sent to railroad offices and other places,) is that of the meridian of the New York City Hall, which is $4^m\ 19^s.58$ slower than that of New Haven, (meridian of the Observatory of the Bureau.)

For facilitating the work of the Bureau an Observatory has been erected on the lot of Mr. Sheffield next north of North Sheffield Hall, and on the same meridian as the Observatory of the Sheffield Scientific School, used by students in Practical Astronomy, the transit instrument of which is used as a collimator for the transit instrument of the Bureau, and *vice versa*. The latter instrument is a fine five-foot transit of four inches aperture by Troughton, which was presented to the College by Dr. William Hillhouse. The office and clock-room of the Bureau is in North Sheffield Hall, the eastern portion of the north room in the basement having been partitioned off, and rented to the Bureau for this purpose. In this room are the sidereal clock and chronograph by Bond for the transit observations, and the standard mean time clock and telegraphic apparatus for the distribution of the time-signals. The standard clock operates also another chronograph in the vaults of the Safe Deposit Company on Orange street, for rating the watches sent by the manufacturers, and there deposited for safe keeping.

The expenses of the Bureau are met by the receipts for the distribution of time-signals and rating time-pieces.

The relation of the work of the Bureau to the watch manufacture will be better understood from the following circular, which defines the conditions of certificates for rates.

Regulations governing the issue of certificates of Rates of Time-pieces.

This Bureau has been established by the Corporation of Yale College, at the recommendation of the Board of Managers of the Winchester Observatory, for the purpose of encouraging the higher development of the horological industries, and to pursue researches calculated to aid in the construction of refined apparatus for the measurement of Time. *In order to* gratify the expressed wish on the *part of the makers for some proper provision* for the rating of their time-pieces,

the Board of Managers have made the necessary arrangements with the Safe Deposit Company of New Haven, for the erection within their steel vaults of the proper hot and cold closets, with appliances for controlling the moisture therein, and for the construction of the most recent forms of ordinary temperature closets. They have also provided for this work those appliances of modern astronomical science which can lessen the amount of personal errors or promise to render the service more exact.

The following regulations governing the reception of time-pieces and the issue of certificates of rates, have been adopted by the Board of Managers:

I. Classes of Certificates.

The following classes of certificates will be issued with time-pieces which have been deposited at this observatory for trial. The certificates will be signed by the Astronomer in charge of the Bureau, and will contain a detailed statement of the results obtained with each particular movement. In describing the positions of a movement the term "Dial up" indicates that the plane of the dial is horizontal and with the engraved side uppermost. "Dial vertical" indicates that the plane of the dial is vertical. The temperature of the refrigerator is approximately 40° F., that of the oven is approximately 90° F., and the ordinary temperature ranges between 65° and 75° F.

1. Class I includes those certificates issued with pocket chronometers or watches which have been subjected while rating to the following variations of position and temperature:

Dial up.	Twelve days at ordinary temperatures.
	One day in the refrigerator.
	One day in the oven.
Dial vertical.	Fourteen days pendant up.
	Two days pendant right.
	Two days pendant left.
Dial down.	Two days.
Dial up.	Eight days.

2. Class II includes those certificates issued with pocket chronometers or watches which have been subjected while rating to the following variations of position and temperature:

Dial up.	One day in the refrigerator.
	One day in the oven.
	Eight days at ordinary temperatures.
Dial vertical.	Eight days pendant up.
	Two days pendant right.
	Two days pendant left.

3. Class III includes those certificates issued with pocket chronometers or watches which have been subjected to the following variations of position:

Dial up.	One day in the refrigerator.
	One day in the oven.
	Eight days at ordinary temperatures.
Dial vertical.	Eight days at ordinary temperatures.

4. *Class* IV, Dial vertical, includes those certificates issued with pocket chronometers or watches which have been rated in the position

Dial vertical.	Twelve days at ordinary temperatures.

5. Class V, Dial up, includes those certificates issued with pocket chronometers or watches which have been rated in the position

Dial up. Twelve days at ordinary temperatures.

6. Class A includes those certificates issued with box chronometers (sidereal or mean time) which have been rated for a minimum period of two months, and have been 24 hours in the oven and 24 hours in the refrigerator.

7. Class B includes those certificates issued with clocks which have been rated for a minimum period of three months at ordinary temperatures, and have been tested for compensation.

8. Class C includes those certificates issued with clocks which have been rated for a minimum period of six weeks at ordinary temperatures.

II. Conditions of issuing Certificates.

No certificates of the classes I, II, III, IV, A, will be issued in the following cases:

1. When the variation of rate with the dial vertical and pendant up in classes I, II, III, and in the positions indicated in classes A and IV, exceeds $2^s.0$ from one day to the following day.
2. When the variation of rate between the positions of "Dial up" and "Dial vertical" exceeds $10^s.0$.
3. When the variation for 1° F. exceeds $0^s.3$ between the ordinary temperature and the oven.
4. When the rate is greater than $10^s.0$ per day.

No certificate in the classes B or C will be issued in the following cases:

5. When the variation of rate from one day to the following day exceeds $1^s.0$, except there be a barometric variation as great as 0.7 inches.
6. When the variation for 2° F. exceeds $0^s.3$.

In the cases where no certificate is issued the movement will be returned to the maker with a statement of its performance.

III. Cost of Certificates.

For the purpose of enabling the Bureau to contribute to its own support as far as possible, the following charges will be made, payable on the notification that the certificates are ready to be issued in the particular cases.

For certificates of the Class I,	$3.00
For certificates of the Class II,	2.50
For certificates of the Class III,	2.00
For certificates of the Class IV,	1.00
For certificates of the Class A,	4.00

For classes B and C a charge will be made to cover the expense of mounting the clock upon the piers, and it will be necessary for persons desiring these certificates to confer, by letter, with the Astronomer in charge of the Bureau.

In the case of movements returned to the makers without certificates, a charge of five cents per day will be made for rating up to the time of such return.

IV. Miscellaneous.

1. All proper precautions will be taken by the Board of Managers against loss or injury by fire, theft or otherwise. The movements will be carefully guarded under the rules *which govern the Safe Deposit* Company. They will not be

opened or in any way tampered with for any reason whatever; and they will not be handled, except by trained observers. If a movement should stop, it will be returned to the sender with an appropriate memorandum; but as it is manifestly inexpedient that a University Corporation should be responsible for loss or damage to property in its care for the purposes specified, it is to be understood that all risks are assumed by the persons who enter the time-pieces for certificates.

2. The Bureau will publish, in the annual report of the Astronomer in charge, the detailed rates of such time-pieces in the various classes as may seem to indicate the development of the horological art.

3. Blanks to be filled out in sending time-pieces to the Bureau will be furnished on application.

4. All movements will be wound immediately on their reception. When they have run down, however, the rating will not commence until they have been running again for five days. Unless requested otherwise, movements will be wound immediately previous to shipment from the Bureau.

5. The P. O. address of this department of the Observatory is Box 853, and time-pieces may be sent by special messenger or express directly to the safes at 89 Orange Street, New Haven, Conn. (The Adams Express Company occupy an adjoining office.)

LEONARD WALDO,
Astronomer in charge of the Horological Bureau.

Approved and ordered to be published by the Board of Managers of the Winchester Observatory.

C. S. LYMAN, *President.* H. A. NEWTON, *Secretary.*

New Haven, Conn., January 1, 1880.

The instrumental equipment of the Bureau is more fully exhibited in the list on the following page, furnished by the Astronomer in charge.

The certificates given for watch movements which have been tested according to the above regulations, state definitely the following particulars with respect to each, viz: mean daily rate, mean variation, variation for 1° Fahrenheit, difference before and after oven and refrigerator, difference between pendant up and dial up, difference between pendant up and pendant right, difference between pendant up and pendant left, difference between dial up and dial down, difference between first and last week, difference between the extremes of rate.

No.	Instrument.	Makers.	Constants.	Remarks.
1	Transit.	Troughton & Simms, London.	Aperture 3.99 in. Focal length 5.1080 ft. Edge of the cube 8.00 in. Diameter of pivots 1.465 in. Value 1 div. of the level 0".930. Value 1 div. of the reticule 1s.495.	Provided with filar micrometer, reversing apparatus, fixed collimators and mounted on granite piers. Reticule of 25 lines by Rogers.
2, 3	Pair of collimators.	Wm. Grunow, New York.	Aperture 1.50 in. Focal length 17.0 in.	Reticules by Rogers.
4	Mean time standard clock.	E. Howard & Co., Boston. No. 191.	Dennison's 4-legged gravity escapement with jewelled pallets. The pendulum has a steel rod with mercurial compensation. Records the even seconds and the last 5 seconds of each minute, but omits the last 20 seconds of each 5 minutes.	An examination of the rates of this clock for a nine months trial at the Harvard College Observatory gives (Feb. to Oct., 1879) smallest mean daily rate —0s.159 (Mar.). Largest mean daily rate —0s.519 (Aug.), and the curve of rates follows the barometric curve.
5	Sidereal time stand'd clock.	William Bond & Son, Boston. No. 367.	Bond's 6-legged gravity escapement. The pendulum has mercurial compensation and steel rod. Records each second except the 59th second of each minute. Jewelled.	Mr. Hartnup of the Liverpool and Prof. Rogers of the Harvard College Observatory have had this clock at different times. Both observers found it an unusally excellent timepiece, the latter giving its extreme variation of rate as 0s.16 for seven months in 1868.
6	Sidereal clock.	Wm. Hillhouse, New Haven.	Dennison's 6-legged gravity escapement. The pendulum has a steel rod with mercurial compensation.	Constructing.
7	Sidereal box chronometer.	Poole, London. Resprung and adjusted by Negus.		Eight day chronometer.
8	Mean time pocket chronometer.	Johnson, London. No. 1436.		
9	Chronograph.	William Bond & Son, Boston. No. 313.	Bond's spring governor. Barrel 13.5 in. long and 6.0 in. diameter. Runs for 2h.5.	Regulated to sidereal time for transit observations.
10	Chronograph.	Alvan Clark & Sons, Cambridgeport.	Clark's conical pendulum governor. Barrel 14.1 in. long and 6.0 in. diameter. Runs for 2h.0	Regulated to mean time for the comparison of timepieces while rating.
11, 12	Repeating relays.	Chas. Williams, Jr., Boston.	Each 8 ohms resistance.	For repeating in three circuits simultaneously. For use with the clocks.
13-25	Telegraph sounders.	Chas. Williams, Jr., Boston.	Each 27 ohms resistance.	For use in distributing time signals on local circuits.
26-35	Thermometers.	Huddleston, Boston.	3 maxima, 3 minima, and 3 ordinary thermometers. Fahreheit's scale.	For use in the oven, refrigerator, and clock case.
36	Thermometer.	Casella, London. No. 29563.	Fahrenheit's scale.	Used as a standard. With Kew verification.
37	Mercurial barometer.	James Green, New York.		
38, 39	Compass galvanometers.	Chas. Williams, Jr., Boston.		For detecting induced currents and tracing telegraphic interruptions.
40	Apparatus for measuring the arc of vibration of a pendulum.	Wm. Grunow, New York.	Reads, for a seconds pendulum, to 5 seconds of arc.	Constructing.
41	Apparatus and closets for the testing of watch & chronome'r movements.	E. Howard & Co., Boston.	Capacity of refrigerator 100 movements. Capacity of oven 100 movements. Capacity of ordinary temperature closets 800 movements.	Refrigerator provided with zinc cases containing the movements surrounded by chemically dried air. Oven heated by coils of pipe through which hot water circulates.

Public Lectures.

The thirteenth annual course of lectures to mechanics and was given during the past year in the lecture room in Sheffield Hall. The lecturers and the subjects are indica the following programme.

I.	Tuesday,	Feb. 11.	—The Wallingford Tornado.	Prof.
II.	Thursday,	" 13.	—The Panic of 1837.	Prof.
III.	Tuesday	" 18.	—The Early History of the Steam Engine.	Prof.
IV.	Thursday,	" 20.	—Granite.	Mr. G. W.
V.	Tuesday,	" 25.	—Force and Design in Nature.	President
VI.	Thursday,	" 27.	—Development of the Egg.	Prof. S. I.
VII.	Tuesday,	Mar. 4.	—The Revision of the Authorized English Version of the New Testament.	Prof.
VIII.	Thursday,	" 6.	—Fundamental Principles of the Strength of Materials.	Prof.
IX.	Tuesday,	" 11.	—The Total Solar Eclipse of July 29, 1878.	Prof. A. W.
X.	Thursday,	" 13.	—The Form of the Law.	Prof. Johnson
XI.	Tuesday,	" 18.	—The Principles of Taxation.	Prof.
XII.	Thursday,	" 20.	—Canterbury Cathedral.	Prof. D. Cady
XIII.	Tuesday,	" 25.	—Trotting Horses.	Prof.

Lectures on Military Science.

A course of lectures on military science, by officers of the Engineering School, at Willet's Point, was delivered in Sheffield Hall as a part of the instruction in the school durir second term of the academic year 1878–79. The order and jects of the lectures were as follows:

I.	Monday,	Mar. 10.	—Strategy and Grand Tactics.	Lieut. G. McC. Derby, U. S. En
II.	Friday,	" 14.	—Logistics.	Lieut. S. W. Roessler, U. S. En
III.	Monday,	" 17.	—Small Arms and their influence on Tactics.	Lieut. W. M. Black, U. S. En
IV.	Friday,	" 21.	—Artillery.	Lieut. J. B. Quinn, U. S. En
V.	Monday,	" 24.	—Fortification.	Capt. A. M. Miller, U. S. En
VI.	Friday,	" 28.	—Torpedoes.	General H. L. Abbot, U. S. En

Gifts.

To the department of Dynamic Engineering the following have been made during the year:

Treatise on Machine Tools, Wm. Sellers & Co., 1877, Philadelphia.
Price Lists and Illustrated Catalogues, Eaton, Cole & Burnham Co., New
General Specifications for an Iron Railway Bridge at Derby, Conn., with dr
from A. B. Hill, C.E., New Haven.

"On the Loss of Heat by Radiation from Steam Boilers," and "Results of a Trial of a Steam Engine built by the J. C. Hoadley Co.," from J. C. Hoadley, Lawrence, Mass., also drawings.

Memoir of the Iron Bridge over the Missouri River at St. Joseph, Mo., by the Detroit Bridge and Iron Works.

Babcock and Wilcox Tubulous Steam Boilers, Descriptive Circulars and Drawings.

Working Bridge Drawings and Details from the Keystone Bridge Co.

Illustrated Album, Delaware Bridge Co.

Working Drawings of Bridges, Detroit Bridge and Iron Works.

Blank Specifications and Drawings from Milwaukee Bridge and Iron Works.

Set of drawings of boilers and boiler settings from Hartford Steam Boiler Inspection and Insurance Co.

Catalogues and Price Lists of Brown and Sharpe Manufacturing Co., Providence.

Descriptive Catalogue and Price List, W. & B. Douglas, Middletown, Conn.

Pocket Companion of useful Tables, etc., Carnegie Brothers & Co., Pittsburgh.

Illustrated Catalogue and Price List of Engineering Instruments from Young & Sons, Philadelphia, also same from Buff & Berger, Boston, from Heller & Brightley, Phila., W. & L. E. Gurley, N. Y., and Fauth & Co. Washington.

"The Methods of Testing Steam Engines," by George P. Hunt, Esq., U. S. Navy; dozen copies.

Illustrated Catalogue, George F. Blake Manufacturing Co.

Illustrated Catalogue, Rumsey & Co., Seneca Falls, N. Y.

Illustrated Catalogue, Morris Tasker & Co., Philadelphia.

"The Chemical Composition and physical properties of Steel Rails," by Charles B. Dudley, Ph.D.

Illustrated Price List, W. C. Duyckinck, New York.

Illustrated Catalogues, Ames Iron Works, N. Y.

Illustrated Catalogues, Providence Tool Co.

Illustrated Catalogues, Knowles Steam Pump Works.

Photographs of Milling machine, Nut facing machine, Cam Milling machines and Gear Cutter, Pratt & Whitney Co., Hartford.

Illustrated Circular of the Buckeye Automatic Cut-off Engine, from J. W. Thompson, Salem, O.

Case of Machine Cut Gears, Pratt & Whitney Co., Hartford.

Forms for Gear Cutters, in case, Pratt & Whitney Co., Hartford.

Set Taps and Dies, in case, Pratt & Whitney Co., Hartford.

Plain and Screw Guages, in Case, Pratt & Whitney Co., Hartford.

Model of Patent Movable Jib Crane, Pratt & Whitney Co., Hartford.

Additions to the Zoological Collections.

A. E. Verrill, Curator.

During the past year the most important additions to the collection have been made through the coöperation of the curator with *Professor Baird, U. S. Commissioner* of Fish and Fisheries.

The curator, as in the eight preceding seasons, during the summer vacation took charge of the investigation of the marine invertebrata of the coast, in connection with the work of the Fish Commission, and the very large collection obtained by dredging off the eastern coast of Massachusetts was sent to the Museum to be elaborated and reported upon, and eventually to be in part distributed to other institutions. This collection filled about forty large cases, and included many thousands of specimens, mostly preserved in alcohol. Mr. Richard Rathbun has been employed by Professor Baird, during the present and past year, at the Museum, to aid the curator in working up the vast amount of material that has thus accumulated in our store-rooms. Mr. Rathbun and Mr. Sanderson Smith were associated with the curator during the summer, in making the collections, and after the curator returned, in September, they continued to carry on the dredging. Mr. Smith has also been engaged at the Museum since his return, in working upon the mollusca obtained during the past and previous seasons. The dredging was carried on, last summer, from Provincetown, Mass., on the U. S. Steamer "Speedwell," Lieut. Z. L. Tanner, Commander. Among others who took an active part in making these collections, Professor H. E. Webster, of Union College, should be particularly mentioned. Another very large and valuable collection, made for the U. S. Fish Commission by the fishermen of Gloucester, Mass., mostly from the deep fishing banks, off Nova Scotia, has also been sent here for elaboration. As fast as these collections are worked up, full series will be deposited in the Museum by the curator. From the Fish Commission we have also received a large and valuable series of the marine fishes of our northern coast, including many of the rare and recently discovered deep-water species. Mr. Rathbun has put up, under the supervision of the curator, fifty sets of duplicates from the Fish Commission collection of invertebrates, to be distributed to various other institutions. Half of these have already been sent away. During the first half of the year, Mr. E. B. Wilson acted as assistant. Subsequently, Miss Bush has been employed in completing the catalogues and writing labels. Mr. E. H. Hawley has, during the year, continued the work of mounting the specimens of shells and other invertebrates in the Museum. This work is so far advanced that all the cases *are now filled*, and many of them over-crowded with specimens *which are, for* the most part, permanently, handsomely, and con-

veniently mounted and labelled. Large numbers of specimens, amounting to more than half of the collection, are still stored in the attic and basement, for want of case-room to exhibit them.

List of Additions.

S. W. Williston, leeches, crustacea, insects and mollusks from Lake Como, Wyoming.

Fred. Habershaw, iguanoid lizard, Panama.

Edward S. Ely, Indian birds.

Geo. W. Potter, copper-head and living black snake, E. Haven.

Geo. B. Grinnell, parasites from trout.

J. B. Neal (S. S. S.), parasites from striped bass.

J. G. Durand, salamander (*Amblystoma punctatum*).

J. T. Mix, ruby-throated humming-bird.

Geological Survey of Canada (through J. F. Whiteaves), collection of corals and echinoderms from Queen Charlotte I., British Columbia; rare coral (*Paragor gia Pacifica* V.) from Vancouver Island, (dep. by A. E. Verrill). Collection of shells, from Queen Charlotte Island, in exchange.

A. H. Thompson, *Squilla empusa*, New Haven.

T. S. Gold, salamander (*Amblystoma punctatum*).

J. B. Bissell and W. H. Fox (S. S. S.), rare toads (*Scaphiopus Holbrookii*), New Haven.

E. C. Allen, skin of black snake.

H. R. Seward, water-snake.

F. S. Smith (S. S. S.), insects, skin of snake, skates, nest and eggs of blue-jay, New Haven.

C. C. Hickox, W. Haven, salt-marsh turtle (*Malacoclemmys palustris*).

A. E. Verrill, striped snake (*Eutænia*), shells, sponges, annelids, insects, etc., New Haven. Lot of mounted birds, W. Medway, Mass., deposited.

E. B. Wilson (S. S. S.), striped snake (*Eutænia*).

Thomas A. Bostwick, turtles (*Aromochelys odorata* and *Chrysemys*), New Haven. Black snake and striped snake, two puffing adders, Plainville, Conn. Red bat, with two young, New Haven.

Thomas Osborne (Y.C.), salamanders (*Amblystoma punctatum*).

F. A. Manning (Y. C.), living snake (*Eutænia saurita*), New Haven.

Professor C. U. Shepard, Amherst College, unique type specimen of a *starfish* (*Goniaster Americanus* Verrill), from off *Charleston, S. C.*

Rev. J. H. Hardy, New Haven, eggs of ring dove.

Miss Essie Shailer, Essex, Conn., eleven bats (*Vespertilio su ulatus*),young and old, living.

Museum of Comparative Zoology, one of the original typ specimens of *Funiculina Forbesii* Verrill, from Scotland.

George E. and A. H. Verrill, New Haven, box-turtle, painte turtles, and large frogs, living.

Horace Bowman, eye-balls of sword fish from off Block Islan collected by Capt. Chas. Smith.

Yale Medical Institute, a lizard, flying fishes, pipe-fish, mor strous chicken, lot of barnacles (*Anatifa*), localities not known lot of crabs and shrimp from the Gulf Stream; chameleon, an locusts, locality unknown.

Sereno Thomas, New Haven, living painted turtle (*Chrysemy picta*) from New Haven.

F. W. Smith, box-turtle, living, from Woodbridge.

J. H. Osborn, M.D., Southington, Conn., a large living rattle snake (*Crotalus horridus*), from Southington, taken by Mr. Newell June, 1879.

Geological Survey of Canada, through J. F. Whiteaves. ! exchange. A valuable lot of shells from Queen Charlotte Islan collected by G. M. Dawson.

Professor D. P. Smith (Yale Med. Inst.), nest of humming bi from East Windsor Hill, *Unio complanatus* from Connecti River.

Virgil M. Dow, New Haven, lot of fishes, reptiles, arachn myriapods, insects, crustacea, etc., in alcohol, native and for no localities given.

H. E. Smith (S.S.S.), injected preparations of leeches.

D. B. Lane, Monroe, two nests of hornets (*Vespa macula*

L. N. Bail (S.S.S.), three living black snakes (*Bascanio strictor*).

George Bifield, New Haven, living puffing adder (*Het platyrhinus*), New Haven.

G. M. Kimball, lot of young striped snakes, (*Eutænia s* taken from one adult female, Rangeley Lake, Maine.

Arthur L. Howard, New Haven, rock eel (*Murænoide natus*).

Gilbert LaVere, E. Haven, living salamander (*Am opacum*).

James Gillin, New Haven, *Ascaris lumbricoides*.

[illegible] (S.S.S.) cast skin of snake.

C. M. Crouse (S.S.S.), living striped snake.

C. J. Rice, North Haven, living salamanders (*Desmognathus*).

Samuel Green, New Haven, young living alligator, from Florida.

H. B. Coffin (S.S.S.), salamander (*Amblystoma opacum*), New Haven.

C. Berns (Y. C.), living turtle "gopher" from Florida.

S. P. Willard (Y. C. 1878), striped snake, New Haven.

Adam Herman, New Haven, mounted skunk, from near New Haven (purchased).

Willis B. Franklin, New Haven, young living alligator, from Florida.

A. E. Verrill (deposited), lot of mounted birds from W. Medway, Mass., collected by C. A. Houghton. Marine invertebrates from Massachusetts Bay, collected by J. H. Emerton. Large series of invertebrata from coasts of New England, Nova Scotia and Newfoundland, from the U. S. Fish Commission. Annelids and other invertebrates, from Cape Cod, collected by Professor H. E. Webster.

Small collections of insects have been presented by E. H. Hawley, Mrs. E. A. Brown, Geo. W. Potter, J. Nettleton, G. J. Brush, Miss Tuttle.

ANNIVERSARY.

The Anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 24, 1879. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

DOCTORS OF PHILOSOPHY (2)

HENRY PRENTISS ARMSBY, Ph.B., *New Haven*. On the Determination of Albuminoids in Feeding Stuffs.

EDWARD HOPKINS JENKINS, B.A., *New Haven*. An Examination of the Methods of Dumas, and of Varrentrapp and Will for Determining Nitrogen.

BACHELORS OF PHILOSOPHY. (40)

HARRY WASHINGTON ASHER (Select), *New Haven*. The Signal Service of the United States.

WILLIAM MONTGOMERY ATWATER, (Select), *New Haven*. Obligation of the Citizen.

NATHANIEL TERRY BACON (Civil Engineering), *Norwich*. Some Experiments on the Position of the Natural Axis in Bent Beams and their Results.

SAMUEL EBEN BARNEY (Civil Engineering), *New Haven*. On the Removal of Tower and Crown Rocks in Boston Harbor.

GEORGE FREDERICK HUNTER BARTLETT (Select), *Buffalo, N. Y.* The Paper Money of the New England Colonies.

MALCOM BOOTH (Dynamic Engineering), *South Kingston, R. I.* The Mechanical Equivalent of Heat.

* WILLIAM JAMES COMSTOCK (Chemistry), *Toledo, O.* The Gibbs Method for Separating Cerium from Lanthanum and Didymium.

ALBERT WILLIAM CONGDON (Civil Engineering), *Brooklyn, N. Y.* On Narrow Guage Railways.

JOHN HOWARD CROMWELL (Dynamic Engineering), *Cranford, N. J.* Plain toothed Gearing.

GEORGE CLARENCE EGAN (Biology), *Chicago, Ill.* History of the Discovery of the Circulation of the Blood.

EMERSON YOUNG FOOTE (Select), *New Haven.* A Review of Coöperation.

NORMAN NORTON FOWLER (Select). *Agawam, Mass.* The Interoceanic Ship Canal across the American Isthmus.

JOHN CURRIER GALLAGHER (Select), *New Haven.* The Objects of Arctic Exploration.

WILLIAM WESLEY GIBSON (Civil Engineering), *New Haven.* The Manufacture and Uses of Biton Aggloméré.

FRANK HANSON HARRISON (Biology), *Indianapolis, Ind.* The Glycogenic function of the Liver.

CHARLES DEVILLIERS HOARD (Select), *Chicago Ill.* The Absolute International Rights of States.

CHARLES PERRY HULL (Biology), *Lebanon.* The Circulatory System of *Amblystoma punctatum.*

JOHN JEWETT (Chemistry), *New York City.* On the influence of Acetic Acid in the separation of Iron as ferric acetate from other metals.

ALFRED DENNIS LEWIS (Select), *Bridgeport.* The Modern Glacier.

GEORGE WALKER MEEKER (Select), *Chicago, Ill.* Tariff Legislature on Iron.

* KAKICHI MITSUKURI (Zoology), *Tokio, Japan.* Anatomy of the common Gray Mussel (*Modiola plicatula* Lamark.)

* JAMES BOYD NEAL, B.A. (Biology), *Bloomsburg, Pa.* The Heart and Aortic Arches in Vertebrates.

EDWARD DELAVAN NELSON (Dynamic Engineering), *New York City.* The Screw Propeller.

* WALTER NORDHOFF (Agriculture), *Alpine, N. J.* Peasant Life in a German Village.

FREDERICK WALLACE PARAMORE (Select), *St. Louis, Mo.* English Occupation of Cyprus.

ROBERT WILSON PATRICK (Select). *Omaha, Nebr.* Transportation in the United States.

HAROLD ROORBACH (Select), *New York City.* The Physical Elements in American Republicanism.

* GEORGE AUGUSTUS SAUNDERS (Civil Engineering), *Newport, R. I.* Modern Turbines as represented by the Swain Turbine.

WILLIAM SETH SILSBY (Dynamic Engineering), *Seneca Falls, N. Y.* The Steam Fire Engine.

RUFUS HENRY SKEEL (Dynamic Engineering), *Newburgh, N. Y.* The Theory and Construction of the Speaking Telephone.

* HERBERT EUGENE SMITH (Biology), *Hartford.* Anatomy of the American Medicinal Leech.

THADDEUS HENRY SPENCER (Dynamic Engineering), *Suffield.* History of the Locomotive.

ISAIAH KIDDER STETSON (Select), *Bangor, Me.* The Importance of the Preservation of Forests.

DANIEL EDDIE STONE (Chemistry), *Cleveland, O.* Methods for the determination of Phosphorus in Pig Iron.

ARTHUR STODDARD VAN VOORHIS (Select), *New York City.* The Chinese Question.

JOHN THOMAS WARING (Select), *Yonkers, N. Y.* Irrigation in India.

WALTER WATSON (Civil Engineering), *Northampton, Mass.* Design of a wrought iron Roof Truss of 200 feet span.

* ALBERT LOWREY WEBSTER (Civil Engineering), *Staten Island, N. Y.* Review of the Musconetcong Tunnel.

* CHARLES SEWARD WILCOX (Dynamic Engineering), *Painesville, O.* The Indicator and the Indicator Diagram.

* WALTER SMITH WILLIAMS (Select), *Evanston, Ill.* The Northeastern Fisheries.

PRIZES.

The following prizes were awarded during the year:

CLASS OF 1879.

For excellence in German, the prize awarded to NATHANIEL TERRY BACON, with honorable mention of ROBERT WILSON PATRICK.

For excellence in French, the prize awarded to GEORGE AUGUSTUS SAUNDERS.

For excellence in Civil Engineering, the prize awarded to GEORGE AUGUSTUS SAUNDERS.

CLASS OF 1880.

For excellence in the Mathematics of Junior Year, the prize awarded to DWIGHT PORTER, with honorable mention of EDWIN MCNEIL ROGERS and HARRY OSBORN CARRINGTON.

CLASS OF 1881.

For excellence in all the Studies of Freshman Year, the prize awarded to ETHAN ALLEN ANDREWS.

For excellence in Mathematics, the prize awarded to ETHAN ALLEN ANDREWS, TIEN YOW JEME and WILLIAM MEEKER WOOD.

For excellence in Physics, the prize awarded to ETHAN ALLEN ANDREWS.

For excellence in Mechanical Drawing, the first prizes awarded to JOHN SLADE ELY and SEYMOUR FRANCIS FRASICK; second prizes to ETHAN ALLEN ANDREWS, GEORGE FREDERICK BOSWORTH, LESTER PAIGE BRECKENRIDGE, CHARLES MANVILLE DOWNS, HENRY HOLBROOK GLADDING, and WILLIS BENTON WRIGHT.

For excellence in English Composition, first prizes awarded to SEYMOUR FRANCIS FRASICK and RICHARD LINDSAY TRUMBULL; second prizes to ETHAN ALLEN ANDREWS, and JOHN SLADE ELY; third prizes to ARTHUR DEAN BEVAN, GEORGE FREDERICK BOSWORTH, GEORGE SHERMAN FOLSOM, HENRY HOLBROOK GLADDING, HOWARD VAN RENSSELAER, and WILLIAM MEEKER WOOD.

CLASS OF 1882.

For the best Entrance Examination, the prize awarded to HARRY WEIR CASEY, *Washington, D. C. Prepared at the* Emerson Institute, Washington, D. C.

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1879-80.

CALENDAR.

1879.		
11 Sept.	Thursday,	First Term begins.
18 Dec.	Thursday,	First Term ends.
1880.		**Winter Vacation of three weeks.**
8 Jan.	Thursday,	Second Term begins.
17 March,	Wednesday,	Spring Recess of two weeks begins.
31 March,	Wednesday,	Spring Recess ends.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday.	Anniversary.
1 July,	Thursday,	Commencement.
2 July,	Friday,	Examination for Admission.
3 July,	Saturday,	
		Summer Vacation of eleven weeks.
14, 15 Sept.	Tues., Wedn.,	Examination for Admission.
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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[ARK BAILEY,		
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Free Hand Drawing.		8 Art School
'REDERICK R. HONEY,		
Descriptive Geometry and Projection Drawing.		14 Lincoln st
'OSEPH J. SKINNER,		
Mathematics.		120 York st.
\UGUST H. EDGREN,		
French.		79 York st.
[OSEPH F. KLEIN,		
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[AMES F. COLBY,		
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\LLEN B. HOWE,		
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RUSSELL H. CHITTENDEN,		
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GRADUATE STUDENTS.

William Whittlesey Abbott, PH.B.	*New Haven,*	257 Church st.
Otis Elihu Atwater, B.A.	*Brattleboro, Vt.*	34 S. M.
Leonard Strong Austin, PH.B.	*Stratford,*	Stratford
John Pomeroy Bartlett, PH.B.	*New Britain,*	16 S. H.
Russell Henry Chittenden, PH.B.	*New Haven,*	95 Humphrey st.
William James Comstock, PH.B.	*Toledo, O.*	37 College st.
Henry Herbert Donaldson, B.A.	*Stockbridge, Mass.*	120 W.
Augustus James Emery, PH.B.	*Bangor, Me.*	544 Chapel st.
Henry Allen Hazen, M.A. Dartmouth College.	*New Haven,*	298 Chapel st.
Jefferson Engel Kershner, B.A. Franklin and Marshall College.	*Leesport, Pa.*	26 Trumbull st.
Joseph Frederick Klein, D.E.	*New Haven,*	86 Nichols st.
Benjamin Franklin Koons, B.A. Oberlin College.	*Sulphur Springs, O.*	36 Court st.
Charles Newton Little, B.A. Nebraska University.	*Lewis, Iowa,*	135 Elm st.
Samuel Lewis Penfield, PH.B.	*Catskill, N. Y.*	14 S. H.
Richard Rathbun, Cornell University.	*Buffalo, N. Y.*	60 Whalley av.
Frederick Sumner Smith, B.A.	*New Haven,*	78 Trumbull st.
Heman Bangs Smith, M.D.	*New Haven,*	102 Howe st.
Ebin Jennings Ward, PH.B.	*Marseilles, Ill.*	251 Church st.
Albert Lowry Webster, PH.B.	*Staten Island, N. Y.*	14 S. H.
Horace Lemuel Wells, PH.B.	*New Britain,*	14 S. H.
Samuel Wendell Williston, M.A. Kansas State Agric. College.	*Manhattan, Kan.*	162 Olive st.
George Leverett Wilson, PH.B.	*West Killingly,*	47 N. S. H.

GRADUATE STUDENTS, 22.

SENIOR CLASS.

ıy Appleton, Jr.	*New York City,*	43 College st.
ıs Ayres,	*Woodmont,*	6½ York sq.
·us Ball,	*New Haven,*	32 Mansfield st.
: Ballard,	*Louisville, Ky.*	464 Chapel st.
ng Bradford,	*Wilmington, Del.*	36 Elm st.
n Carrington,	*New Haven,*	527 Chapel st.
ır Chanute,	*New York City,*	66 w.
ington Clark,	*Norwich,*	19 Trumbull st.
es Coffin,	*Edgartown, Mass.*	128 High st.
n Colby,	*St. Johnsbury, Vt.*	7 Library st.
pine Collin,	*Penn Yan, N. Y.*	27 Prospect st.
ie Crouse,	*Syracuse, N. Y.*	36 Elm st.
npson Dodd,	*West Meriden,*	6½ York sq.
;e,	*Stamford,*	525 Chapel st.
·ard Doolittle,	*Onarga, Ill.*	36 Elm st.
·d Emery,	*Fair Haven,*	17 Crown st.
ard Goodspeed,	*East Haddam,*	189 George st.
ı Hardenbergh,	*Jersey City, N. J.*	36 Elm st.
ıd Higginson,	*Newburgh, N. Y.*	43 College st.
ıcock,	*Cheshire,*	19 Trumbull st.
nahan Hooper,	*Baltimore, Md.*	169 Temple st.
: Ingersoll,	*New Haven,*	85 Trumbull st.
ıd Jensen,	*Cleveland, O.*	6½ York sq.
ı Lewis,	*Utica, N. Y.*	38 Elm st.
›philus Liefeld,	*New Haven,*	36 Orchard st.
McCrea,	*Chicago, Ill.*	36 Elm st.
ead,	*Pittsburgh, Pa.*	36 Elm st.
Munger,	*Watertown,*	27 Prospect st.
·er Needham,	*Hartford,*	36 Elm st.
·iance Osborn,	*New Haven,*	150 York st.
ımin Phelps, Jr.	*Watertown, N. Y.*	36 Elm st.
er,	*Hartford,*	14 Lock st.
·man Porter,	*Stowe, Vt.*	23 Prospect st.
ette Reynolds,	*Chicago, Ill.*	464 Chapel st.
·il Rogers,	*Central City, Col.*	66 w.
Rogers,	*Lexington, Mass.*	36 Elm st.
·ert Sargent,	*New Haven,*	51 Elm st.
·lett Schofield,	*West Point, N. Y.*	201 Orange st.
weather,	*New Haven,*	State Hospital.
; Wadsworth,	*Farmington,*	165 Temple st.
dee Warren,	*Buffalo, N. Y.*	84 Wall st.
eric Wehner,	*New Haven,*	544 Chapel st.
lwin Williams,	*Glastonbury,*	128 High st.

SENIORS, 43.

JUNIOR CLASS.

Charles Francis Adams,	*Jessups, Md.*	36 Elm st.
Ethan Allen Andrews,	*Tarrytown, N. Y.*	175 Temple st.
George Jackson Angell,	*Brooklyn, N. Y.*	167 Temple st.
Edward Bailey,	*Harrisburgh, Pa.*	459 Chapel st.
Frank Lewis Bigelow,	*New Haven,*	278 Grange st.
George Frederick Bosworth,	*Milford,*	94 Olive st.
Lester Paige Breckenridge,	*Westfield, Mass.*	114 High st.
Charles Sheldon Burnham,	*Woodbridge,*	
Charles Monroe Carpenter, Jr.	*Brooklyn, N. Y.*	92 w.
Frederick Casper,	*West Meriden,*	196 Crown st.
Charles Chamberlain,	*Brooklyn, N. Y.*	55 Trumbull st.
Howard Field Chappell,	*Chicago, Ill.*	36 Elm st.
George Strong Daniels,	*New York City,*	92 w.
Harry Sprague Davidson,	*San Francisco, Cal.*	432 Chapel st.
Charles Manville Downs,	*New Haven,*	70 Wooster st.
Oliver Winchester Dye,	*New Haven,*	194 Prospect st
John Slade Ely.	*New York City,*	71 w
George Sherman Folsom,	*Northford,*	161 George st.
William Henry Fox,	*Washington, D. C.*	6½ York sq.
Seymour Francis Frasick,	*Hartford,*	99 Wall st.
Albert Moses Gerstle,	*Youngstown, O.*	6 Orange st.
Henry Holbrook Gladding,	*New Haven,*	170 Martin st.
William Loomis Griswold,	*Banksville,*	127 Whalley av.
Frederic Jonathan Hiller,	*Cohoes, N. Y.*	71 w.
Samuel Higgins,	*Buffalo, N. Y.*	74 High st.
Frank Allison Hubbard,	*Sandusky, O.*	59 w.
Blain Jamison,	*New Orleans, La.*	55 Trumbull st.
Jeme Tien Yow,	*Canton, China,*	169 Temple st.
Edmund Parker Lord,	*Saxonville, Mass.*	86 w.
Richard Becker Lyon,	*New Haven,*	710 Chapel st.
Silas Metzger,	*New Haven,*	17 Grove st.
Edwin Kirtland Morse,	*Poland, O.*	49 Grove st.
Marcus Daty Munn,	*Southington,*	127 Whalley av.
Marvin Olcott,	*Corning, N. Y.*	86 w.
Owyang Keng,	*Canton, China,*	169 Temple st.
Francis Stuyvesant Peabody,	*Chicago, Ill.*	36 Elm st.
Oliver Phelps,	*Canandaigua, N. Y.*	59 w.
Harry Smith Pope,	*Jersey City, N. J.*	57 w.
Addison Alexander Righter,	*Newark, N. J.*	73 w.
John Hutchinson Robinson,	*Lake Village, Ark.*	6½ York sq.
George Lewis Sargent,	*New Haven,*	51 Elm st.
Joseph Denny Sargent,	*New Haven,*	51 Elm st.
Louis Jacob Schiller,	*New Haven,*	8 Martin st.
Bernard Joseph Shanley,	*New Haven,*	211 Franklin st.
Frank Augustus Smith,	New Haven,	36 Lyonst.

Henry Taber,	*New York City,*	33 Prospect st.
John Heyward Trumbull.	*Talcahuano, Chili,*	41 Trumbull st.
Richard Lindsay Trumbull,	*Talcahuano, Chili,*	41 Trumbull st.
John Henry Ullrich,	*Decatur, Ill.*	6½ York sq.
Howard VanRensselaer,	*Albany, N. Y.*	23 Prospect st.
Frank Charles Warner,	*West Suffield,*	305 Orange st.
Robert William Watson,	*Ashtabula, O.*	65 w.
Harry Yale Witbeck,	*Chicago, Ill.*	6½ York sq.
William Meeker Wood,	*Morristown, N. J.*	6 High st.
Arthur Burnham Woodford,	*West Winsted,*	116 College st.
Charles Worthington Wright.	*West Roxbury, Mass.*	82 Wall st.
Willis Benton Wright,	*Cromwell,*	88 Grove st.

JUNIORS, 57.

FRESHMAN CLASS.

orace Ellsworth Andrews,	*Cleveland, O.*	162 York st.
lfred Warren Armstrong,	*Cleveland, O.*	162 York st.
arles Noyes Batcheller,	*Wallingford, Vt.*	60 w.
nry Jonathan Biddle,	*Philadelphia, Pa.*	4 Library st.
ncis Hayes Blake,	*New Haven,*	Mill Rock.
han Gross Bozeman,	*New York City,*	420 Chapel st.
ry Weir Casey,	*Washington, D. C.*	82 Wall st.
iam Anson Chamberlin,	*New Haven,*	30 Trumbull st.
Yung Chun,	*Canton, China,*	169 Temple st.
g Ching Chung,	*Canton, China,*	464 Chapel st.
am Henry Crocker,	*San Francisco, Cal.*	489 Chapel st.
r Root Downs,	*New Haven,*	64 La Fayette st.
John Drummond,	*Winfield, Ill.*	25 Prospect st.
t Ogden DuBois,	*New Haven,*	328 Howard av.
Mortimer Dunham,	*Unionville,*	60 w.
l Lawrence Everit,	*New Haven,*	281 Whitney av.
t Waldron Faulkner,	*Stamford,*	59 Wall st.
ier Bryan Johnson,	*Utica, N. Y.*	64 w.
Deatherage Lacey,	*Brooklyn, N. Y.*	38 Elm st.
k William La Forge,	*Waterbury,*	547 Chapel st.
dson Lambert,	*New Haven,*	12 Eld st.
Smith Latham,	*Manchester,*	120 Dwight st.
White Lynde,	*West Brookfield, Mass.*	140 High st.
anforth MacQuesten,	*Washington, D. C.*	86 Wall st.
ward Malley,	*New Haven,*	714 Chapel st.

Sheldon Elton Minor,	*Thomaston*,	547 Chapel s
Nagamoto Okabe,	*Tokio, Japan*,	6 Trumbull s
Edward E. Paramore,	*St. Louis, Mo.*	38 Elm s
Frank Spooner Parrott,	*Bridgeport*,	94 Grove s
Lewis Valentine Pirsson,	*New York City*,	121 Park s
James Edward Pope, Jr.	*Jersey City, N. J.*	57 w
Edward Rahm,	*Pittsburgh, Pa.*	56 w
Robert Browning Rood,	*Great Barrington, Mass.*	8 Lock s
Alfred Hughes Rowe,	*Fair Haven*,	Fair Have
William Bradbury Spring,	*Portland, Me.*	86 Wall s
Charles Edward Stockder, Jr.	*West Meriden*,	6½ York s
Fred Moore Strong,	*Topeka, Kansas*,	38 Elm s
Arthur Graham Thompson.	*Milford*,	6½ York s
Edwin Thorne,	*Garrisons, N. Y.*	65 Whitney a
Thomas Pearsall Thorne,	*Millbrook, N. Y.*	65 Whitney a
Walter Joy Vought,	*Buffalo, N. Y.*	110 w
Edward Loder Whittemore,	*Rye, N. Y.*	143 York s
Alfred Buckingham Willcox,	*Chicago, Ill.*	106 w
Chauncey Pratt Williams, Jr.	*Albany, N. Y.*	134 College s
S. Lawrence Williams,	*Chicago, Ill.*	86 Wall s
Chan Lok Wing,	*China*,	59 Wall s

FRESHMEN, 46.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Samuel Forbes Adam,	*Canaan.*	
Louis Norton Bail,	*New Haven*,	43 Park s
Louis Asta Buruaga,	*Santiago, Chili*,	109 Elm s
Frederick Burr Clemmons,	*New Haven*,	162 Putnam s
Edwin James Leonard,	*Davenport, Iowa*,	22 Trumbull s
Joseph Singler,	*Ansonia.*	
Warren A. Spalding,	*New Haven*,	89 Church s
Henry Roemer Stadtmueller,	*New Haven*,	43 Whitney a
Louis Weld Stadtmueller,	*New Haven*,	43 Whitney a

SPECIAL STUDENTS, 9.

SUMMARY.

GRADUATES,	22
SENIORS,	43
JUNIORS,	57
FRESHMEN,	46
SPECIAL,	9
TOTAL,	177

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction nd researches in the mathematical, physical, and natural sciences, ith reference to the promotion and diffusion of science, and also) the preparation of young men for such pursuits as require special proficiency in these departments of learning. It is one of he Departments of Yale College, like the law, medical, theologi- al, and art schools, having its separate funds, buildings, teachers, nd regulations, but governed by the Corporation of Yale Col- ege, which appoints the professors and confers the degrees. It s, in part, analogous to the academic department, or classical col- ege, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scien- tific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the con- gressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts *for Connecticut.*" Since that time, and *especially since the autumn of 1869,* numerous liberal gifts have

been received from the citizens of New Haven, and from oth gentlemen in Connecticut, New York, and St. Louis, for tl endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a Sta Board of Visitors, consisting of the Governor, Lieutenant-Go ernor, three senior Senators, and the Secretary of the State Boa of Education; and this Board, with the Secretary of the Scie tific School, is also the Board for the appointment of students hold the State scholarships.

At the request of the Governing Board, the Corporation Yale College has also appointed a Board of Councillors for t School, consisting of a number of gentlemen who have taken deep interest in its welfare.

The Governing Board consists of the President of Yale C lege and the Professors who are permanently attached to t School. There are several other instructors associated with the a part of whom are connected with other departments of tl College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in t Scientific School is mainly carried on are called Sheffield Hall a North Sheffield Hall; but instruction in Mineralogy, Geolog and Biology, including Zoölogy and Comparative Anatomy, now given entirely in the Peabody Museum. These halls co tain a large number of recitation and lecture rooms, a hall f public assemblies and lectures, chemical and metallurgical labor tories, a photographical room, an astronomical observatory museums, a library and reading room, besides studies for some c the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belong ing to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photograph and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons *Cambridge*, a meridian circle, etc.
6. *A Collection of* Mechanical Apparatus, constituting the "Collier Cabinet."

7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that *given by the graduate instructors* in other departments

of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of minerals species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time,

to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering,
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall *appear to him* to be favorable to professional *progress.*

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid and spherical; including fundamental notions of symmetry, and examples of loci and of maxima and minima of plane figures:—an equivalent of the nine books of Chauvenet's Treatise, or of the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions, and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in *Wheeler's* Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

In his preparation in GEOMETRY the candidate should, as far as practicable have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the *requirement*, the following works are specifically named, *among which the candidate for examination* may make his own selection.

These are Harkness's "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, July 2, 3, and on Tuesday and Wednesday, September 14, 15, 1880. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1880 examinations (for the Freshman Class only) will also be held in Chicago and in Cincinnati (beginning on Friday, July 2, at 9 A. M.), at a place to be announced in the local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to these examinations.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in Composition. *Mathematics*—Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Elementary Projection Drawing; Isometric Drawing; Descriptive Geometry.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing; Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves; Location of line of Railroad, with calculations of Excavation and Embankment; Henck's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials; Bridges and Roofs, begun; Stone Cutting, with graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs; Building Materials; Stability of Arches and Walls; Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism; Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. French.

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for wheels; Parallel Motions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—The application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Theory of the Arch; Construction of Roof Trusses, Girders and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow-Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks, Cross-heads; Pipe Connections, Valves, Cylinders, Stuffing Boxes, Glands, etc. *Shop Visits.* Blowpipe Analysis. *French.*

SECOND TERM—*Hydrostatics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc. *Hydrodynamics*—Water Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of Pipes. *Thermodynamics*—General principles of Heat employed as a source of Power; Construction of Steam Engines; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designs for Machines with working drawings. Design for Hoisting Engine; Shearing and Pumping Engine; High Speed Steam Engine. *Shop Visits and Reports. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Organic Chemistry*—Lectures and Recitations. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Physiology*—Huxley's. *Botany*—Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—History of Agriculture and Sketches of Husbandry in Foriegn Countries; Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History).

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory Practice Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Physiology*—Huxley's, with Demonstrations. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiological Chemistry*—Sanderson's Handbook. Recitations and Laboratory Work. *Mineralogy*—continued. *Botany*—Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—*Dana's Manual. French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Roger's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *History*—Constitutional History of the United States; Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English*—Shakspere, Milton, Dryden, Pope, and later authors. *History*—Political History of United States. History of Europe from 18—48; Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine *Arts.* After the completion of the course in free-hand drawing, *instruction is* given by Mr. F. R. Honey, during the second term

in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of *minor importance.*

In Zoology excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are *provided* as follows: in the Center Church (Cong.); in the *Trinity (Epis.)*; and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 17–18.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 16, 1880. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must *be citizens of Connecticut*. In case there are more

applicants than vacancies, candidates will be preferred who lost a parent in the military or naval service of the United St and next to these such as are most in need of pecuniary a ance; and the appointments will be distributed as far as p cable among the several counties in proportion to their popul The appointing Board for the current year, consisting of the E of Visitors of the State and the Secretary of the School, will on June 29th, 1880, and at or about the same time in the 1881, due notice of which will be given by publication in county of the State. All applications should be made previ that time. Blank forms for application will be sent, requested, by Professor GEORGE J. BRUSH, Secretary o Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the mencement week in Yale College, when selections from the uation theses are publicly read. The degrees are publicly ferred by the President and Fellows of Yale College on mencement Day.

APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1879, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JUNE, 1879.

1. Find the least common multiple of 7379 and 9263.

2. Reduce 525 metres to feet.

3. If $9\frac{1}{2}$ yards of cloth can be bought for $\$44\frac{1}{8}$, how many yards can be bought for $\$33\frac{1}{4}$?

4. For what sum must a note be given at bank, payable in 4 months, at 6 per cent. discount, to obtain $1000?

5. By selling land at $88.14 per acre, I shall gain 13 per cent. For how much must I sell it to gain 20 per cent.?

6. A certain room is 16 feet long, 15 feet wide and 12 feet high. What is the distance from the right hand upper corner to the left hand lower corner?

ARITHMETIC.

SEPTEMBER, 1879.

1. Reduce to its lowest terms $\frac{8398}{29393}$.

2. If 5 men build 75 rods 2 ft. 6 in. of wall in 7 days, how much will 1 man build in 1 day?

3. An agent bought land at 5 per cent. commission. The amount of his commission was $150. What amount did he pay for land?

4. A owes B $15,000, $\frac{1}{3}$ due in 3 years, $\frac{1}{3}$ in 4 years, $\frac{1}{4}$ in 6 years, and the balance in 8 years; what is the equated time for the payment of the whole?

5. Name the principal metric units of length, weight, and capacity. State their relations to one another, and give an equivalent of each in the common system.

6. Two globes, each 5 inches in diameter, and 2 cubes, each 5 inches in length, were melted into one cube; how long was the side of this cube?

GEOMETRY.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

I.—*Plane Geometry.*

1. Define similar polygons. Prove that two triangles are similar when they are mutually equiangular.

2. Two triangles having an angle of the one equal to an angle of the other are to each other as the products of the sides including the equal angles.

3. To inscribe a circle in a given triangle.

4. The side of a regular inscribed hexagon is equal to the radius of the circumscribed circle.

5. Define the term *locus* and give an example of a plane locus. When are two points said to be symmetrical with respect to a straight line, and what is the line then called? Of all triangles having the same base and equal perimeters, what one has the greatest area? How do you find the circumference and area of a circle when the radius is given? how, the area of a trapezoid? how, that of a regular polygon?

II.—*Solid and Spherical Geometry.*

6. If two angles, not in the same plane, have their sides respectively parallel and lying in the same direction, they are equal and their planes are parallel.

7. If a pyramid be cut by a plane parallel to its base: 1st, the edges and the altitude will be divided proportionally; 2d, the section will be a polygon similar to the base.

8. If two triangles on the same sphere are mutually equilateral, they are also mutually equiangular.

9. Write expressions for the surface and volume of a sphere, the surface of a zone, and the volume of a spherical sector.

NOTE.—Candidates who present themselves for the whole examination may omit questions 2 and 3.

Candidates who present themselves for the partial examination, will answer the questions only in Plane Geometry.

GEOMETRY.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

1. To construct a triangle equivalent to a given polygon.
2. To inscribe a regular decagon in a given circle.
3. If two planes are perpendicular to each other, a straight line drawn in one of them perpendicular to their intersection is perpendicular to the other.
4. Define a polyhedron and a prism. The sections of a prism made by parallel planes are equal polygons.
5. Define a polar triangle.
   1. If A′B′C′ is the polar triangle of ABC, then ABC is the polar triangle of A′B′C′.
   2. In two polar triangles each angle of one is measured by the supplement of the side opposite to it in the other.
6. The convex surface of a cone of revolution is equal to the product of the circumference of its base and half its slant height.

ENGLISH.

JUNE, 1879.

1. Parse the words in the following sentences:—
   (*a*) The course that he took was one which, under the circumstances, could not be justified.
   (*b*) To fly from need not be to hate mankind.
2. State the various classes of nouns.
3. Inflect throughout the pronoun of the third person.
4. Explain the characteristics of the two conjugations of the English verb, the Old or Strong, and the New or Weak conjugation; and give illustrative examples of each.

ALGEBRA.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

I.

1. Find the greatest common divisor of

$3x^3-13x^2+23x-21$ and $6x^3+x^2-44x+21$.

2. A grocer has two kinds of tea, one worth a cents per pound, the other b cents. How many pounds of each must be taken to form a mixture of n pounds which shall be worth c cents per pound?

3. Given $x-\frac{y-a}{b}=c$; $y-\frac{a-x}{b}=d$, to find x and y.

4. (1.) From $\sqrt[3]{192}$ take $\sqrt[3]{24}$. (2.) Divide $4\sqrt[3]{12}$ by $2\sqrt{3}$. (3.) Divide $a^{\frac{1}{2}}+64b^{\frac{1}{2}}$ by $a^{\frac{1}{6}}+4b^{\frac{1}{6}}$. (4.) Multiply $\sqrt{-a}+\sqrt{-b}$ by $\sqrt{-a}-\sqrt{-b}$.

II.

5. A person bought a number of sheep for a dollars. If he had bought $2b$ more for the same money, he would have paid c dollars less for each. How many did he buy?

6. Resolve the trinomial $3x^2-10x-25$ into factors.

7. Deduce the formula for finding the number of permutations (or arrangements) that can be made of n things taken m at a time.

8. Write the formula for the development of $(x+a)^m$. If m is entire and positive, how many terms will it contain? How many, in any other case?

9. Define the logarithm of a number and a system of logarithms. What is the base of the common system? In this system what numbers have negative logarithms? What logarithms would be negative in a system formed with the base 0.5?

What operations are facilitated by the use of logarithms? Give the rules for performing them.

10. Obtain a formula for finding in what time a sum of money will double at a given rate of compound interest?

NOTE.—The first division of the paper extends as far as Quadratic Equations, and will be all that is required of candidates who propose to pass the partial examination only.

Candidates who present themselves for examination in the whole of the required Algebra, may omit *questions 1 and 2.*

ALGEBRA.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

1. Given $\frac{m}{x}+\frac{n}{y}=a$; $\frac{n}{x}+\frac{m}{y}=b$, to find x and y.

2. Simplify the following expressions:

(1.) $\sqrt[3]{27x^6y^{15}}$; (2.) $8(\frac{3}{4})^{\frac{1}{2}}+\frac{1}{2}(12)^{\frac{1}{2}}-\frac{1}{3}(27)^{\frac{1}{2}}-2(\frac{3}{16})^{\frac{1}{2}}$;

(3.) $[ab^2.(ab^3)^{\frac{1}{2}}.(ab^4)^{\frac{1}{3}}.(ab^5)^{\frac{1}{4}}]^{\frac{1}{5}}$; (4.) $(\sqrt[3]{-1})^4$.

3. Solve the equation $3x-\frac{6x^2-40}{2x-1}-\frac{3x-10}{9-2x}=2$.

4. Solve the equation $\frac{\sqrt{a+x}}{\sqrt{x}}+\frac{\sqrt{a-x}}{\sqrt{x}}=\sqrt{\frac{x}{b}}$.

5. What debt may be discharged in a year by paying $1 the first month, $2 the second, $4 the third, and so on, each succeeding payment being double the last; and what will be the last payment?

6. Expand $\frac{3+2x}{5+7x}$ into a series by the method of undetermined coefficients.

7. Expand $(a^3-x^3)^{-\frac{1}{3}}$ by the binomial formula.

8. Solve the equation $a^{bx+d}=c$.

TRIGONOMETRY.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

1. Find the length of an arc of 15° in parts of the radius.

2. Make a table of the algebraic signs of the trigonometrical functions of arcs terminating in each of the four quadrants.

3. Make a table of the values of the functions of 0°, 90°, 180°, 270°.

4. What is the smallest angle that has the same functions as that of 420°? Write equivalent expressions for the following: cos (270°−x), tan (360°−x).

5. Given sin $a=m$, to find all the other functions of a, supposing a an angle of the second quadrant.

6. Show that $\tan(x+45°)+\tan(x-45°)=\frac{4\tan x}{1-\tan^2 x}$.

7. In a right triangle ABC given, A=90°, AB=246.32, AC=380.07, to find the angles B and C and the hypothenuse BC.

8. Explain the method of solving a triangle when two sides and the included angle are given.

TRIGONOMETRY.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

1. The circular measure of a certain angle is 1.5; find the corresponding number of degrees.

2. Explain the changes in magnitude and sign of the trigonometrical functions of an arc as the arc increases from 0° to 360°.

3. State five fundamental relations which exist between two or more of the trigonometric functions.

5. Deduce the formula $\tan(a\pm b)=\frac{\tan a\pm\tan b}{1\mp\tan a\tan b}$.

5. Given $\tan(45°-b)+\cot(45°-b)=4$; find tang b and give the corresponding angles if you remember them.

6. A tower stands by a river. A person on the opposite bank finds its elevation to be 60°; he recedes 40 yards in a direct line from the tower and then finds the elevation to be 50°; find the breadth of the river.

7. Deduce the formula $a^2=b^2+c^2-2bc\cos A$, in which a, b, c, are the sides of a triangle and A the angle opposite the side a. What use *have you made of this* formula, if any?

LATIN.

JUNE, 1879.

I. Translate as literally as possible—

a. His Caesar ita respondit: Eo sibi minus *dubitationis* dari, quod eas res, quas legati Helvetii commemorassent, memoria teneret; atque *eo* gravius ferre, quo minus *merito* populi Romani accidissent; qui si allicujus injuriae sibi conscius fuisset, non fuisse difficile cavere.

b. Postquam omnes Belgarum copias in unum locum coactas ad se venire vidit, neque jam longe abesse ab his, quos miserat, exploratoribus et ab Remis cognovit, *flumen* Axonam, quod est in extremis Remorum finibus, *exercitum* transducere maturavit, atque ibi castra posuit.

c. Ita commutata fortuna, eos, qui in spem potiundorum *castrorum* venerant, undique circumventos interficiunt et ex *hominum* millibus amplius triginta, quem *numerum* barbarorum ad castra venisse constabat, plus tertia parte interfectâ reliquos perterritos in fugam conjiciunt, ac ne in locis quidem superioribus consistere patiuntur.

d. Est autem hoc Gallicae *consuetudinis*, uti et viatores etiam invitos, consistere cogant, et, quid quisque eorum de quaque re audierit aut cognoverit, quaerant, et *mercatores* in oppidis vulgus circumsistat, quibusque ex regionibus veniant quasque ibi res cognoverint, pronuntiare cogant.

e. Accedebat huc, quod jam in concilio Aeduorum Dumnorix dixerat, sibi a Caesare regnum civitatis deferri; quod dictum Aedui graviter ferebant, neque *recusandi* aut deprecandi causa legatos ad Caesarem mittere audebant. Id factum ex suis hospitibus Caesar cognoverat.

f. Interim, confecta frumentatione, milites nostri clamorem exaudiunt: praecurrunt equites; quanto sit res in periculo, cognoscunt. Hic vero nulla munitio est, quae perterritos recipiat: modo conscripti atque *usus* militaris imperiti ad tribunum militum centurionesque ora convertunt: quid ab his praecipiatur, exspectant.

II. 1. Decline *minus* (1), *flumen* (8), *locis* (15).

2. Compare *minus* (1), *gravius* (3), *extremis* (9).

3. Write the synopsis, active and passive, of *posuit* (10).

4. State the mood and tense of the following: *commemorassent* (3), *cogant* (18), *circumsistat* (20), *praecipiatur* (32).

5. Give the principal parts of the following: *accidissent* (4), *cavere* (5), *cognovit* (8), *conjiciunt* (15), *patiuntur* (16), *cogant* (18), *audebant* (25), *praecurrunt* (28), *cognoscunt* (29), *perterritos* (29), *convertunt* (31), *praecipiatur* (32).

6. State the construction of all italicized words.

7. Quote from the above text an example of *oratio obliqua*.

8. Convert into *oratio directa* the example quoted in answer to question seventh.

LATIN.

SEPTEMBER, 1879.

Translate as literally as possible—

a. Quibus rebus cognitis, quum ad has suspiciones certissimae res accederent, quod per fines Sequanorum Helvetios transduxisset, quod obsides inter eos dandos curasset, quod ea omnia, non modo *injussu* suo et civitatis, sed etiam inscientibus ipsis, fecisset, quod a magistratu Aeduorum accusaretur, satis esse *causae* arbitrabatur, quare in eum aut ipse animadverteret, aut civitatem animavertere juberet.

b. Pro his Divitiacus facit verba: Bellovacos omni *tempore* in fide atque amicitia civitatis Aeduæ fuisse: impulsos a suis principibus, qui dicerent Aeduos a Cæsare in servitutem redactos omnes indignitates contumeliasque perferre, et ab Aeduis defecisse et *populo* Romano bellum intulisse.

c. Quorum *adventu* magna cum auctoritate et magna cum hominum multitudine bellum gerere conantur. Duces vero ii deliguntur, qui una cum Quinto Sertorio omnes *annos* fuerant summamque scientiam rei militaris habere existimabantur. Hi *consuetudine* populi Romani loca capere, castra munire, *commeatibus* nostros intercludere instituunt.

d. Itaque vocatis ad se undique mercatoribus, neque quanta esset insulæ magnitudo, neque quæ aut quantæ nationes incolerent, neque quem usum belli haberent aut quibus *institutis* uterentur, neque qui essent ad majorum navium multitudinem idonei portus, reperire poterat.

e. His rebus cognitis, Cæsar legiones equitatumque revocari atque in itinere resistere jubet, ipse ad naves revertitur: eadem fere, quæ ex nuntiis litterisque cognoverat, coram perspicit, sic ut amissis circiter quadraginta navibus, reliquæ tamen refici posse magno *negotio* viderentur.

f. Magnum ibi numerum versuum ediscere dicuntur: itaque *annos* nonnulli vicenos in disciplina permanent. Neque fas esse existimant ea litteris mandare, quum in reliquis fere rebus, publicis privatisque rationibus, Græcis *litteris* utantur.

II.—1. Decline *obsides* (3), *magistratu* (5), *verba* (8), *majorum* (22).

2. Compare *certissimæ* (1–2), *summam* (16), *majorum* (22).

3. Write the synopsis, active and passive, of *dicerent* (10).

4. State the mood and tense of the following: *accederent* (2), *dicerent* (10), *poterat* (23), *perspicit* (26), *utantur* (32).

5. Give the principal parts of the following: *accederent* (2), *juberet* (7), *redactos* (11), *defecisse* (12), *conantur* (14), *deliguntur* (15), *incolerent* (21), *reperire* (23), *perspicit* (26), *refici* (27), *permanent* (30), *utantur* (32).

6. State the construction of all italicized words.

7. Quote from the above text an example of *oratio obliqua.*

8. Convert into *oratio directa* the example quoted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1879.

1. The Belgæ[1] are[2] in[3] arms[4].
2. Cæsar ascertains[5] (that) the Belgæ are in arms.
3. Cæsar ascertained (that) the Belgæ were in arms.
4. Cæsar ascertained: "The Belgæ were in arms.
5. The Belgæ drove-out[6] the Gauls.
6. The Gauls were driven-out[7] by the Belgæ.
7. Cæsar inquired what[8] states[9] were in arms.
8. The Belgæ descended[10] from[11] the Germans[12].
9. When[13] Cæsar inquired[14], he ascertained (that) the Belgæ were in arms.
10. When Cæsar had inquired, he ascertained (that) the Belgæ had descended from the Germans.

[1] Belgæ.
[2] esse.
[3] in.
[4] arma.
[5] reperire.
[6] expellere.
[7] ab.
[8] quis.
[9] civitas.
[10] oriri.
[11] ab.
[12] Germani.
[13] quum.
[14] quaerere.

LATIN EXERCISES.

SEPTEMBER, 1879.

1. Cæsar encouraged[1] the minds[2] of the Gauls[3].
2. The minds of the Gauls were encouraged by[4] Cæsar.
3. Cæsar attended to this matter—(*literally*, "this[5] matter[6] was[7] (for) an object-of-attention[8] to Cæsar").
4. Cæsar promised[9] (that) he would attend to this matter.
5. Cæsar promised: "I will attend to this matter."
6. Cæsar had great[10] hope[11] (that) Ariovistus would put-an-end[12] to (his) injuries[13].
7. Cæsar said[14] he had great hope (that) Ariovistus would put an end to (his) injuries.
8. Translate sentence seventh in such a manner as to illustrate direct statement (*oratio directa*).

[1] confirmare.
[2] animus.
[3] Gallus.
[4] ab.
[5] is.
[6] res.
[7] esse.
[8] cura.
[9] polliceri.
[10] magnus.
[11] spes.
[12] finem facere.
[13] injuria.
[14] dicere.

HISTORY OF THE UNITED STATES.

JUNE, 1879.

escribe the settlement of Pennsylvania; state what explo- and settlements were made by the French in North a prior to 1750.

hen and from whom did the United States acquire Louisi- lorida, Alaska?

rrange the following events in the order in which they d, with their dates: discovery of Gold in California, ion of Vermont to the Union, adoption of the Missouri omise, Lee's surrender to Grant, war against Mexico, battle r Orleans, opening of Pacific Railroad.

ell what you can of Jackson's administration; of Van s.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1879.

When, where and by whom were permanent settlements in North America prior to 1621?

What was the Nullification Act? What was the Embargo

ive the contending parties and the (approximate) dates e following battles: Trenton, Gettysburg, Queenstown, Gordo, Antietam.

Tell what you can of the administrations of John Adams e, Pierce.

GEOGRAPHY.

JUNE, 1879.

1. Bound the state of Missouri; name three of its largest cit and tell how they are situated; what are the principal rivers it or on its borders?

2. Describe Lake Michigan; tell what bays or gulfs open in it; what states touch it; and what are the principal cities on i shores?

3. Where does the Columbia River rise, run and empty; an what states, territories and provinces does it touch?

4. What countries or provinces and islands does the Equat cross?

5. Bound France; describe two of its cities; describe two its rivers.

6. Where are the following cities: Berlin, Buffalo, Belfas Buenos Ayres, Bremen, Bombay?

GEOGRAPHY.

SEPTEMBER, 1879.

1. Bound the State of Texas; name two of its more importa cities and tell how they are situated; what are the princip rivers in it or on its borders?

2. Where does the Potomac River rise, run, and empty; wh States does it touch; what are the principal cities on its banks?

3. Describe the Alleghany Mountains, their position and cours

4. What countries does the Tropic of Cancer cross?

5. Where is Russia? tell what seas and gulfs touch its bc ders; name three of its cities and tell how they are situate name three of its rivers and tell where they empty.

6. Where are the following places: Milwaukee, Valparai Havre, Damascus, Sydney, Tunis?

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Yale University

FIFTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1880-81.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

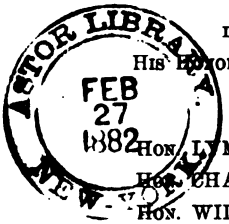
NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR.
1881.

State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOAR FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Excellency CHARLES B. ANDREWS, Litchfield.



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129.

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GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly:

The State Board of Visitors of the Sheffield Scientific School have the honor herewith to transmit, for the use of the Legislature, the fifteenth Annual Report of the Governing Board of that institution. Every member of the Legislature will doubtless examine the report sufficiently to learn its general import. It will be seen that the scope of the educational work which is being carried on by this School is substantially the same as for the two or three preceding years. We bear cheerful testimony to the zeal and fidelity with which the entire corps of teachers have discharged their labors. The great value of their work cannot be easily estimated. Nowhere in the State, if in the whole country, are the practical, working sciences, out of which comes the comfort, prosperity and wealth of the New England people, better taught than here.

We call attention to the Horological and Thermometric Bureaus *which have been established* since the last report.

The School is in a high state of prosperity; the number of students is largely increased, and there seems a greater desire to obtain the free scholarships.

Intellectual research is extending more and more into those fields where truth can be tested by ordeal. Dogmatism is falling into disfavor and the Experimental Sciences are becoming more popular. These are results which naturally flow from that condition of society in which the largest personal freedom unites with the widest liberty of opinion and the most intrepid spirit of inquiry. The Sheffield Scientific School is the outgrowth of such a condition. Its very existence proves that ours is a free government. Its growing strength and prosperity gives assurance that a free government cannot soon fail. We commend it to the favorable consideration of the General Assembly.

By order of the Board.

CHARLES B. ANDREWS,

Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Fifteenth Annual Report the Governing oard of the Sheffield Scientific School have no changes of mo- ient to record. The number of students has increased materially ver that of the last year: but the future alone can decide whether his is due to accidental causes, or to the reviving interest in sci- ntific studies which owes its origin to the reviving prosperity of he country. In the internal history of this institution there has een but little variation. The courses of instruction can undergo ut little alteration, so long as their present means only are at the lisposal of the Governing Board, and improvements, which it is lesirable to make, must be deferred to a period when the re- ources of the School have been increased sufficiently to justify heir introduction.

It is with regret that the Governing Board are compelled to nention the loss of one of the warmest friends of the School, the Honorable Oliver F. Winchester, who died at his residence in this ity, on Friday the tenth of December, 1880. The attention of Mr. Winchester was early directed to the desirability of establish- ng this department of Yale College on a secure basis, and as far ack as 1855 he subscribed five thousand dollars towards the sum vhich those interested in it were then seeking to raise for its en- lowment. Nor did his interest so early manifested ever abate, nd in recognition of this fact he was made one of the Councillors f the School upon its reorganization in 1869. More recently his egard for science and scientific instruction has been signally manifested by the large gift he made of land to the College for the purpose of founding the observatory, which has been called from his name. Though under special trustees of its own, and therefore *not directly connected* with the Scientific School, its

aims are in many respects so alike that its developments and growth must necessarily be attended with more especial benefit to this department than to most of those allied under the name of Yale College.

Winchester Observatory.

Horological and Thermometric Bureaus.

1. The Horological Bureau continues to occupy the room in North Sheffield Hall, which it rents for a computing and clock-room. This room contains, besides a Bond's Chronograph, three standard clocks of the highest grade, mounted on separate piers, in closets with non-conducting walls for protection against sudden changes of temperature. These clocks, together with another in a room near by, and the tower clock of the City Hall (connected electrically with a sounder in the clock room), are compared daily and tested for rate by observations made in the special observatory of the Bureau. From one of these—the standard mean time clock by Howard,—the exact time is regularly distributed by telegraph to various offices in the city and to the chief railroads of the State. The railroads at present thus directly served are the New York, New Haven & Hartford, the Boston & New York Air Line, the Connecticut Western, the Connecticut Valley, and the Naugatuck. Other railroads obtain their time from these.

The standard of time adopted is that of the meridian of the New York City Hall, which is slow of Boston $11^m\ 46^s.3$, and of New Haven (Hor. Obs.) $4^m\ 19^s.58$, and is fast of Washington $12^m\ 10^s.5$.

The City Hall Clock, (a fine one by Howard, with Denison gravity escapement and a three hundred and fifty pound mercurial two-second pendulum,) is connected, as above stated, with the clock room of the Bureau, and proves to be comparable for steadiness of rate with standard astronomical clocks of the first class. Its error is generally less than one second, and is not allowed to exceed two or three seconds at a maximum. Its daily variations of rate are very small fractions of a second. The *first* stroke of the bell marks the precise beginning of each hour—an allowance of course being made for the velocity of sound, of one second for every seventy rods that the observer is distant from *the City Hall.*

One of the three standard clocks mentioned above was pre-

ented to the Bureau early in the year by its maker, Dr. William Hillhouse of New Haven, who also gave many years ago the fine ransit instrument by Troughton, now used in the Observatory f the Bureau. This clock is of the finest workmanship, has a ouble three-legged Denison escapement, and a mercurial compenation pendulum of the unusual weight of about sixty-five pounds. ts performance is very satisfactory, though it has not yet been ully investigated.

The testing of fine watches, both for manufacturers and indiiduals, under the regulations published in the circular of the Bureau, which was given in the last Report, has been successfully arried on during the year at the vaults of the New Haven Safe Deposit Company, where the time pieces are deposited for safe eeping, and where also there is a chronograph electrically conected with the standard mean time clock for facility in rating, s well as the hot and cold closets for testing the effects of temperature.

In May and June a systematic series of telegraphic observaions was undertaken on several nights by Dr. Waldo at the Observatory of the Bureau and Prof. Wm. A. Rogers at Harvard College Observatory, for the exact determination of the difference of longitude between these points,—the observers interchanging places on half the evenings to eliminate the effects of personal equation. The Observatory is under obligations to the Director of the Observatory of Harvard College, Professor Pickering, and to the officers of the Western Union Telegraph Company, who have afforded every facility for the successful carrying out of the longitude determination.

The reduction of the observations has not yet been completed, but is well advanced.

Two students in practical astronomy have been employed in the computations and other work of the Bureau during the year.

Neither the time service nor the testing of watches, it may be proper to say, has thus far proved as remunerative as the large cost to the Bureau and the acknowledged benefit of these services to great public and private interests would lead us to expect, yet there is reason to believe that the importance of both is gradually becoming more and more appreciated, and that ultimately they will not fail of an adequate support.

The Time Service, especially, is of vital importance to the railroad interests of *the State, and* through them to the whole com-

munity, inasmuch as it promotes safety in the running of trains, and secures in all places accurate and uniform time. It is hoped, therefore, that the Legislature of the State, in view of the great public benefit of this service, will see fit to relieve the observatory of the expense of maintaining it.

Dr. Leonard Waldo is the Astronomer in Charge of the Horological Bureau, and with Mr. William Beebee as assistant, has the entire management of its affairs.

2. THE THERMOMETRIC BUREAU, also in charge of Dr. Waldo, is another branch of service undertaken recently by the Observatory. Its organization and purpose are fully explained in the following published circular, which is here inserted entire.

CIRCULAR CONCERNING THE VERIFICATION OF THERMOMETERS.

This Bureau has been established by the Corporation of Yale College, at the recommendation of the Board of Managers of the Winchester Observatory, in order to afford desired facilities for the adequate verification of thermometers.

Thermometers will be received by the observatory for the purpose of comparison with the observatory standards, and certificates of comparison signed by the Astronomer in charge will be issued with thermometers so compared. These certificates will contain a statement of the corrections to be applied at intervals of five or ten degrees of the thermometer scale to cause it to have the same reading as the observatory standards. In general these corrections will be expressed in tenths of one degree.

Thermometers sent for verification must have a name and number engraved upon them; and thermometers which are not graduated on the glass stem must be of sufficiently good workmanship to satisfy the observer in charge that the scale will not suddenly change with reference to the glass stem of the thermometer tube, with ordinarily careful usage.

The Board of Managers have established the following scale of charges for this service, which includes certificate:—

Standard Meteorological Thermometers with independent freezing point determination,	$2.00
Standard Meteorological Thermometers,	1.00
Ordinary Meteorological Thermometers,	.50
Ordinary Maximum Thermometers,	.75
Ordinary Minimum Thermometers,	.75
Clinical Thermometers,	.50

There will be a deduction of one-fifth of the above charges where more than eight thermometers of one kind are received at the same time. In the case of clinical thermometers the charge will be four dollars per dozen when not less than two dozen are sent at the same time.

For other thermometers than the above the charges for verification will be furnished on application.

The letter of advice accompanying thermometers sent for verification should

contain the maker's name, the number of each thermometer, and full directions for reshipment.

All proper precautions are taken by the Board of Managers to guard against loss or injury; but as it is manifestly inexpedient that a University Corporation should be responsible for property in its care for such a purpose, it is to be understood that all risks are assumed by the person sending the thermometers.

LEONARD WALDO,
Astronomer in Charge.

Approved and ordered to be published by the Board of Managers of the Winchester Observatory.

C. S. LYMAN, *President.* H. A. NEWTON, *Secretary.*

New Haven, Conn., June 1, 1880.

Statistics show that several thousand thermometers of refined construction, and graduated on the stem to 0°.2 F. or thereabouts, are annually procured by the medical practitioners of our country alone for physiological researches and daily practice. The majority of these thermometers are newly made (within six months), and their verification depends on inferior (from the scientific standpoint) thermometers in the hands of individual makers. It is needless to say that the readings of such thermometers have little value in indicating the true temperature of a patient, or affording data in cases which the physician wishes to describe in print.

The makers of thermometers in our country have been in general content to use for their standards, thermometers which have not been recently compared at a foreign observatory or with some more easily accessible instrument in which they place confidence, in the hands of a friendly neighbor. Thus it happens that many thousand American clinical thermometers have been sold, which do not depend upon a comparision with a recognized standard for their scale readings. The result has been that the American instruments have suffered in the estimation of scientific practitioners. This is not so much the fault of the American makers as their misfortune in not having the same facilities offered them by the properly equipped observatories this side of the water, which their favored competitors enjoy abroad.

The meteorological observers in this country have now no common standard of easy access; and it seems eminently proper that the observatory should undertake to be useful to the medical profession and the meteorologists in this country, and afford the means of comparison desired. With this end in view, the observatory has accepted the aid of the Board of Directors of the Bache Fund of the National Academy in obtaining the standards of the foreign observatories, and has made provision for the constant determination of the errors of the standards themselves.

In order to encourage the manufacture of thoroughly seasoned thermometers for physicians' use, the observatory will receive from the makers thermometer tubes which *have been numbered but not* graduated, and will seal such tubes in

boxes in such a manner that they can only be opened by breaking the seals. After not less than one year the boxes may be opened by an observatory officer, and in the certificates of verification furnished with these thermometers the length of time they have been under the observatory seal will be stated. The observatory charge for recording and sealing such thermometers will be $1.00 per hundred, and makers desiring to avail themselves of this privilege will send such boxes to the observatory for sealing.

The observatory will make arrangements with hospitals and other institutions using a number of thermometers, for the systematic examination at stated intervals of all thermometers in their use. Such an arrangement precludes errors arising from the use of newly made instruments which have been verified, but whose scales have not yet attained an approximately permanent position.

Ordinary and clinical thermometers are returned within three days from the time of their reception, if the observatory charges for verification are remitted with the thermometers.

In case they are not so remitted, they are payable upon notification by the observarory that the thermometers are ready to be returned.

Dealers and manufacturers furnishing satisfactory references to the observatory may open an account, to be settled quarterly, beginning with January 1 of each year.

The Thermometric Bureau is under the immediate charge of Dr. Leonard Waldo. The observatory also receives the advice of Professor J. Willard Gibbs and Professor Arthur W. Wright in regard to problems connected with thermometry.

NOTICE.

To insure the safe transmission of thermometers by express, they should be packed in two boxes, one inside the other, and the space filled with cotton-wool or its equivalent. Single clinical thermometers may be packed in wooden boxes and sent by mail. New York makers desiring to send thermometers by hand may do so by leaving them with Lockwood's private express, care Oelschlaeger Bros., 162 William Street. The P. O. Address of the Observatory is Box 85. The Office is at 89 Orange Street, to which all packages may be directed.

The following standards will be used by this department of the Observatory for the verification of thermometers:—

Designation.	Maker.	Maker's Number.	How Graduated.	Length of 1°.	Smallest Graduation.	Length of Tube.	Shape of Bulb.	Remarks.
ndard Air Thermometer.								**
mary Standard.	Kew Observatory.	595	—34°to +275°C.	1.73 mm.	1°	618 mm.	Cylindrical.	Kew Observatory, 1880. Filled in 1867.
" "	Kew Observatory.	578	— 9 to +105 C.	3.46 "	0.5	455 "	"	Kew Observatory, 1880. Filled in 1868.
" "	Kew Observatory.	584	+14 to +220 F.	1.87 "	1	455 "	"	Kew Observatory, 1880. Filled in 1868.
" "	Casella, London.	35247	+30 to +214 F.	1.38 "	1	390 "	"	Filled in 1867, Graduated 1879.
" "	R. Fuess, Berlin.	89	— 6 to +105 C.	4.15 "	0.1	650 "	"	Patent, 1877.
" "	R. Fuess, Berlin.	50	— 2 to +105 C.	4.05 "	0.2	573 "	"	Patent, 1877.
" " (Five).	Baudin, Paris.		C.		0.1 and 0.2			**
" "	Fastré Ainé à Paris.	*594	—13 to +85.6 C.	3.62 "	*	550 "	"	Filled in 1854.
" "	Fastré Ainé à Paris.	*596	—35 to +84.2 C.	2.60 "	*	508 "	"	" 1854.
r Standards.	Tonnelot à Paris.	2584 to 2587	+ 5 to +230 F.	1. 8 "	0.5	455 "	"	" 1879–4.
ondary Standard.	Casella, London.	35242	+10 to +215 F.	1.59 "	1	378 "	"	Filled in 1867. Graduated 1879.
" "	Casella, London.	35246	+27 to +212 F.	1.85 "	1	382 "	"	Filled in 1867. Graduated 1879.
" "	Fuess, Berlin.	586 b.	—24 to + 55 C.	2.44 "	0.2	302 "	Spherical.	
" "	Greiner & Geissler, Berlin.	601	—19 to + 45 C.	3.94 "	0.2	245 "	"	Date 1873 on the Scale.
" "	Greiner & Geissler, Berlin.	508	—27 to + 50 C.		0.2	298 "	"	
" "	F. G. Greiner.	600	— 1 to + 27 R.	9.50 "	0.1	413 "	Cylindrical.	Date 1852 on the Scale.
" " (Two).	Baudin, Paris.		F.		0.5			**
parison Thermometers.								
Twenty-Five.	Alvergniat Freres.							**
Six.	Casella, London.	Various Numbers.	—20 to +133 F.	about 1.7 mm.	1	200 "	Spherical.	
One.	Fuess, Berlin.	59	— 8 to +105 C.	2.27 "	1	299 "	Cylindrical.	
	Baudin, Paris.							**
ical Thermometers.								
Four.	Alvergniat Freres.							**
Four.	Casella, London.	Various Numbers.	+30 to +130 F.	about 3.5 "	0.2	253 "	Cylindrical.	
Two.	Fuess, Berlin.	84 and 85	+26 to + 46 C.	about 7.2 "	0.1	238 "	"	
Registering Thermometer.	Casella, London.	9738	—15 to +135 F.	1.69 "	1	308 "	Spherical.	Maximum.
"	Casella, London.	9930	—25 to +120 F.	1.66 "	1	337 "	"	Minimum (spirit).

Besides these there are some twenty-five thermometers, by various reputable makers, self-registering and otherwise, to be used as occasion requires.

* Loaned from the Physical Laboratory by Professor Arthur W. Wright. Arbitrary graduations. ** Not yet received.

The following pieces of apparatus are also in use in the thermometric work:

1. A Crouch microscope comparator. 2. A pair of microscopes provided with eye-piece micrometers, and objectives of four inch equivalent foci by Beck. 3. A small vertical cathetometer by Wm. Grunow, graduated to single millimeters, the vertical motion being 220^{mm} and the telescope having an eye-piece micrometer by Rogers. 4. A superior standard barometer, "Jas. Green, N. Y., 957," with half-inch mercury column and reading to 0.001 inches. 5. A freezing-point apparatus of two liters capacity, consisting of a tinned iron vessel within another, the space between them filled with cotton-wool. 6. A boiling-point apparatus constructed of brass after the plan of Regnault. 7. An improved boiling-point apparatus constructed entirely of glass. 8. An elaborate apparatus of brass for accurately and rapidly comparing clinical thermometers, in a suitable water bath.

Six hundred thermometers have already been carefully tested in the few months since the work was commenced, and the constantly increasing demand for this service gives promise that it will prove highly beneficial alike to the medical profession and to the science of the country.

Public Lectures.

The fourteenth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and the subjects are indicated in the following program:

I.	Thursday, Feb.	5.—Hybridism.	Prof. Daniel C. Eaton.
II.	Tuesday, "	10.—Christian Iconography; illustrated from Amiens Cathedral.	Prof. D. Cady Eaton.
III.	Thursday, "	12.—Dogs.	Prof. Brewer.
IV.	Tuesday, "	17.—The Heroic Element in Historical Persons and Eras.	Prof. Fisher.
V.	Thursday, "	19.—The Story of a Light House.	Prof. DuBois.
VI.	Tuesday, "	24.—Telling the Time.	Dr. L. Waldo.
VII.	Thursday, "	26.—Adulteration of Foods.	Prof. Johnson.
VIII.	Tuesday, Mar.	2.—Nutrition.	Mr. R. H Chittenden.
IX.	Thursday, "	4.—The Culture and Preparation of Tea.	Prof. S. Wells Williams.
X.	Tuesday, "	9.—Fundamental Ideas in Mechanics.	Dr. Skinner.
XI.	Thursday, "	11.—The Giant Cephalopods or "Devil-fish" of the North Atlantic.	Prof. Verrill.
XII.	*Tuesday,* "	16.—Modern Sanitary Science.	Prof. Brewer.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willet's Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1879–80. The order and subjects of the Lectures were as follows:

I.	Monday, Feb.	23.—Strategy and Grand Tactics.	Lieut. G. McC. Derby, U. S. Engineers.
II.	Friday, "	27.—Logistics.	Lieut. James L. Lusk, U. S. Engineers.
III.	Monday, Mar.	1.—Small Arms and their influence on Tactics.	Lieut. W. M. Black, U. S. Engineers.
IV.	Friday, "	5.—Artillery.	Capt. J. B. Quinn, U. S. Engineers.
V.	Monday, "	8.—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI.	Friday, "	12.—Torpedoes.	General H. L. Abbot, U. S. Engineers.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

During the past year the most important of the additions to the Zoological collections have been due to the coöperation of the curator with the U. S. Fish Commission, as in previous years, in the exploration of the sea-bottom along our coasts.

The head-quarters of the Commission were at Newport, R. I., this season, and the dredging and trawling was carried on from that point over a wide area, both in the shallower waters and southward to the distant banks, from 70 to 115 miles off shore, and to a depth of 500 fathoms, with very great success.

This year the new steamer "Fish Hawk," of 480 tons, built and fitted expressly for the scientific work of the Fish Commission, was employed in these explorations. The commander, Lieut. Z. L. Tanner, U. S. N., also made another trip, after the regular work of the season was over, to the deep-water off the mouth of Chesapeake Bay, with excellent results. The very extensive and valuable series of Invertebrata, obtained during these explorations, as well as numerous collections contributed to the Fish Commission by the bank fishermen of Gloucester, Mass., have all been sent to the Museum to be elaborated and reported upon, and eventually to be distributed.

Mr. A. Agassiz has sent to the curator and Professor S. I. Smith, for elaboration, the Cephalopoda, Crustacea and Anthozoa obtained by him while exploring the bottom beneath the Gulf Stream, along the U. S. Coast, this season, on the Coast Survey steamer *"Blake."*

These several collections are not only very large and interesting, but they contain large numbers of genera and species wholly unknown before, as well as very many others that are new to our coast.

In these explorations, this season, the curator was assisted especially by Mr. Richard Rathbun, Mr. Sanderson Smith, and Mr. J. H. Emerton. Messrs. B. F. Koons and E. A. Andrews of this School, also joined our party, and were very useful assistants.

Professor S. I. Smith has, as usual, taken charge of the Crustacea, and has very thoroughly revised the Decapoda of northern New England. He has prepared for publication in the Proceedings of the National Museum accounts of the numerous new and strange forms of Crustacea obtained in deep-water, off our coast. He has also revised certain groups of the Amphipoda, and printed the results in the Transactions of the Connecticut Academy, Vol. IV. Mr. Oscar Harger has printed in the report of the U. S. Commissioner of Fish and Fisheries, an extended monograph of the Isopoda of New England, upon which he has for several years been engaged. Mr. E. B. Wilson has printed, in the same report, his monograph of the Pycnogonida of New England. The curator has published, in the Trans. Conn. Acad., Vol. V., the first part of a monograph of the New England Cephalopoda, including all the gigantic species hitherto discovered; the second part of this work is now printing. He has also printed more or less detailed accounts of the most interesting forms of Mollusca and Echinoderms obtained in deep-water off our coast, in the American Journal of Science, and in the Proceedings of the National Museum. These several reports are all based on specimens in the Yale Museum, and are profusely illustrated. They represent an important part of the scientific work done in the Museum during the past and previous years. Mr. J. H. Emerton, in addition to his ordinary duties, has made large numbers of excellent drawings to illustrate some of the reports referred to above, and for others now in progress.

Mr. Sanderson Smith and Mr. Richard Rathbun have been employed in the Museum during a part of the year, at the expense of the U. S. Fish Commission, to aid the curator in working up the large amount of material that has accumulated in our storerooms.

Miss K. J. Bush has been employed in completing and *copying* the permanent catalogues, in writing labels for those

ecimens that are on exhibition, and in other clerical duties. Her ork has been done very carefully and is, in all respects, highly tisfactory. Mr. E. H. Hawley, during the first part of the year, ntinued the mounting of the specimens of shells and other vertebrates in the Museum. But this work has been discontin-d for want of funds.

Aside from the large collections of the U. S. Fish Commission, ferred to above, the following have been received:

Gardiner Morse, Jr., *Gammarus fasciatus*, Mumford, N. Y.

Robt. T. Morris, living puffing adder.

Edw. E. Brewster (S. S. S. 1878), nest and eggs of woodcock, rnwall, Conn., collected April 24, 1879.

Mrs. M. C. Reid, New Haven, a starfish (*Asterias Forbesii*), ith eight arms (a monstrosity), from Bridgeport.

Publishers of Evening Register, New Haven, an ermine, col-cted by Fred. Hotchkiss, in Woodbridge.

C. W. Canfield (S. S. S. 1878), eggs of *Rana sylvatica*, taken larch 13, at Westerly, R. I.

Col. G. L. Febiger, rare land shells, from Louisiana.

Capt. Davis, Stony Creek, squilla and young lobster.

Mrs. E. A. Brown, barnacles from bottom of vessel.

Geo. W. Potter, E. Haven, living copper-head snake (*Ancis-rodon contortrix*), and two living black snakes, East Haven.

Adrian Ohule, living puffing adder.

Wm. G. Daggett (Y. C.), living snapping turtle.

O. W. Atwater, living water-snake (*Tropidonotus sipedon*).

B. F. Koons (S. S. S.), eggs of wood turtle (*Glyptemys insculpta*), and spotted turtle (*Nanemys guttata*), New Haven.

C. M. Crouse (S. S. S.), living striped snake and two moles (*Scalops aquaticus*), from New Haven; craw-fish, Central New York.

E. V. Reynolds (S. S. S.), a miscellaneous collection, from New Haven, from Nassau, W. I., etc.

Prof. A. E. Verrill, brown snake (*Storeria Dekayi*); milk-snake (*Ophiobolus*); nest and eggs of vireo; large fiddler-crabs (*Gelasimus minax*), Annelids, etc., from New Haven.

E. A. Andrews (S. S. S.), spotted turtles (*Nanemys guttata*), New Haven.

R. C. Ballard (S. S. S.), collection of fossils.

James Snedeker, New Haven, a wood turtle (*Glyptemys insculpta*), and nest with eggs of marsh wren.

C. D. Hall, orange file-fish, from Madison.

W. F. Lane, Wallingford, little auk (*Mergulus alle*), from Guilford.

J. H. Emerton, a mole (*Scolaps aquaticus*), New Haven; nudibranch mollusca from Salem, Mass.

Horace Bowman, New Haven, cluster of oysters on a living quahog clam, orange file-fish, rudder-fish, and other fishes, New Haven.

John G. Brady (Y. C. 1874), sea-pen (*Verrillia Blakei*), from Alaska.

Samuel W. Williston, a valuable collection of named Diptera from Connecticut and California; rare birds' eggs, from Rocky Mountains.

John Pardee, living alligator from Florida.

R. S. Griswold, living alligator from Florida.

Josephus Rice, salamanders (*Desmognathus fucus*), from North Haven.

Adam Herman, New Haven, star-nosed mole, mounted, and monstrous frog, with double hind legs.

W. J. Comstock (S. S. S. 1879), toad from Hamilton Inlet, Labrador.

Prof. E. S. Dana, snakes from St. Johns River, Florida.

Prof. J. K. Thacher, larvæ of lamprey eel.

Richard Westbrook, hoary bat (*Lasiurus cinereus*), from New Haven.

National Museum, Washington, D. C., coach-whip snake and king-snake, from Florida.

Mrs. Chas. Ives, New Haven, several sponges and a rare coral (*Eusmilia*), from Nassau.

John Booth, New Haven, monstrous flask-shaped hen's egg.

Anonymous. Red-throated diver, mounted, from Alabama.

Small collections of insects have been received from S. B. Cocks, W. Van Name, Forest Shepard, F. S. Smith, Dr. H. Van Hoosear, Geo. B. Lobdell, Jr., and others.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 29, 1880. The candidates for degrees with the subjects of their graduation *theses* are given in the following schedule. Those marked with *an asterisk* were read in the evening.

CIVIL ENGINEERS. (2)

DWIGHT EDWARD PIERCE, Ph.B., *South Bethlehem, Pa.* Design for an Iron Railroad Bridge.

EBEN JENNINGS WARD, Ph.B., *Marseilles, Ill.* A Review of the Glascow Steel Bridge.

DYNAMIC ENGINEER. (1)

AUGUSTUS JAMES EMERY, Ph.B., *Bangor, Me.* The More Important Principles which should Govern the Design and Construction of the Steam Engine.

BACHELORS OF PHILOSOPHY. (42)

DANIEL SYDNEY APPLETON (Select), *New York City.* On the United States Life-Saving Service.

CHARLES RUFUS AYRES (Select), *Woodmont.* On Agricultural Underdrainage.

CHARLES BACKUS BALL (Civil Engineering), *New Haven.* On the American Engineering Contract System.

ROGERS CLARK BALLARD (Chemistry), *Louisville, Ky.* A Method of Analysis for the Lead Furnace Slags.

HARRY BANNING BRADFORD (Dynamic Engineering), *Wilmington, Del.* On the Determination of the Mechanical Equivalent of Heat.

HARRY OSBORN CARRINGTON (Dynamic Engineering), *New Haven.* On the Steam Injector.

JOSEPH ARTHUR CHANUTE (Chemistry), *New York City.* On Thomas and Gilchrist's Process for Dephosphorizing Iron.

GEORGE HUNTINGTON CLARK (Civil Engineering), *Norwich.* A Review of the Magnetic Iron Ore Mines of Morris County, N. J.

ARTHUR BAYLIES COFFIN (Biology), *Edgartown, Mass.* On the Circulatory System of the Dog.

EDWARD ALLEN COLBY (Chemistry), *St. Johnsbury, Vt.* On the Separation of Manganese from Calcium and Magnesium.

FRANK MCALPINE COLLIN (Select), *Penn Yan, N. Y.* On the Tenure of Land in Ireland.

CHARLES MABIE CROUSE (Natural History), *Syracuse, N. Y.* On the Structure of *Scolopendrium vulgare.*

CHARLES THOMPSON DODD (Dynamic Engineering), *West Meriden.* On Fuel and its Combustion in relation to Steam Boilers.

ARTHUR DODGE (Dynamic Engineering), *Stamford.* On Superheated Steam.

THOMAS EDWARD DOOLITTLE (Biology), *Onarga, Ill.* On the Circulatory System of the Shad.

JACOB EDWARD EMERY (Select), *Fair Haven.* On the Acquisition and Distribution of the Public Lands of the United States.

GEORGE EDWARD GOODSPEED (Select), *East Haddam.* On the Population of the United States.

JOHN WARREN HARDENBERGH (Civil Engineering), *Jersey City, N. J.* A Review of the Metropolitan Elevated Railroad.

LOUIS MAYNARD HIGGINSON (Select), *Newburgh, N. Y.* On the Contributions of Professor Cairnes to Political Economy.

WALTER HITCHCOCK (Biology), *Cheshire.* On the Nervous System of *Diemictylus viridescens.*

THEODORE LANAHAN HOOPER (Dynamic Engineering), *Baltimore, Md.* A Discussion of Slide Valves by means of Zeuner's Valve Diagrams.

COLIN MACRAE INGERSOLL (Dynamic Engineering), *New Haven.* On the Trowbridge-Mather Automatic Boiler.

MARTIN EDWARD JENSEN (Chemistry), *Cleveland, O.* Analysis of Cymatolite.

*DAVID BROWN LEWIS (Civil Engineering), *Utica, N. Y.* On the Belgian System of Cable-Towing as used on the Erie Canal.

ERNEST THEOPHILUS LIEFELD (Select), *New Haven.* On the Treatment of Criminals.

*WILLEY SOLON MCCREA (Select), *Chicago, Ill.* On the Problem of Transportation.

JOHN MOORHEAD (Chemistry), *Pittsburg, Pa.* On the Best Volumetric Methods of Determining Iron.

*CARL EUGENE MUNGER (Biology), *Watertown.* On the Digestive System of *Bascanion constrictor.*

EDWARD BUTLER NEEDHAM (Biology), *Hartford.* On the Respiration of the Frog (*Rana fontinalis*).

GEORGE BENJAMIN PHELPS (Biology), *Watertown, N. Y.* On the Rate of Elimination of Arsenic by the Kidneys.

*DWIGHT PORTER (Civil Engineering), *Hartford.* On Storage Reservoir, No. 2, at Farmington, Conn.

EDWARD FREEMAN PORTER (Select), *Stowe, Vt.* On the Effect of Machinery on Wages.

EDWARD VILETTE REYNOLDS (Natural History), *Chicago, Ill.* On the Appendages of the Hermit Crab (*Eupagurus pollicaris*).

*EDWIN MCNEIL ROGERS (Dynamic Engineering), *Central City, Col.* Design for a Gravity Road.

GEORGE BLISS ROGERS (Select), *Lexington, Mass.* On Rent.

EDWARD RUPERT SARGENT (Select), *New Haven.* On the Panic of 1873.

WILLIAM BARTLETT SCHOFIELD (Dynamic Engineering), *West Point, N. Y.* On the History of the Locomotive Steam Engine.

HENRY STARKWEATHER (Dynamic Engineering), *New Haven.* On the Value of the Condenser in the Economy of Fuel.

ADRIAN ROWE WADSWORTH (Civil Engineering), *Farmington.* On the Hartford Sewage System.

WILLIAM CANDEE WARREN (Select), *Buffalo, N. Y.* On the Signal Service of the United States.

ADOLPH FREDERIC WEHNER (Dynamic Engineering), *New Haven.* On the Magneto-Electric Machine.

GEORGE GOODWIN WILLIAMS (Select), *Glastonbury.* On the Suppression of the Theater during the Reign of Charles I.

Prizes.

owing prizes were awarded during the year:

CLASS OF 1880.

in German, the prize awarded to Frank McAlpine Collin, with le mention of George Huntington Clark and Ernest Theophilus

in French, the prize awarded to Dwight Porter.
in Civil Engineering, the prize awarded to Dwight Porter.

CLASS OF 1881.

in the Mathematics of Junior Year, the prize awarded to William Wood, with honorable mention of George Frederick Bosworth, en Yow, and Willis Benton Wright.

CLASS OF 1882.

in all the Studies of Freshman Year, the prize divided between Harry asey and Frank Judson Lambert.
in German, the prize divided between Frederick William LaForge man Smith Latham, with honorable mention of Kee Yung Chun.
in Mathematics, the prize divided between Harry Weir Casey and Judson Lambert.
in Physics, the prize awarded to Harry Weir Casey.
in Chemistry, the prize awarded to Frank Judson Lambert.
in Descriptive Geometry, the prize divided between Harry Weir nd Frank Judson Lambert.
in English Composition, first prizes awarded to Henry Jonathan Harry Weir Casey, James John Drummond, Robert Ogden Frederick William LaForge, and Sheldon Elton Minor; second o Nathan Gross Bozeman, Alexander Bryan Johnson, Norman atham, and Lewis Valentine Pirsson.

CLASS OF 1883.

Entrance Examination, the prize awarded to John Alpheus Allen, *ven.* Prepared at the Hillhouse High School, New Haven.

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1880-81.

CALENDAR.

1880.		
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.
1881.		**Winter Vacation of three weeks.**
13 Jan.	Thursday,	Second Term begins.
13 April,	Wednesday,	Spring Recess begins.
20 April,	Wednesday,	Spring Recess ends.
28 June,	Tuesday,	Meeting of Appointing Board
28 June,	Tuesday,	Anniversary.
29 June,	Wednesday,	Commencement.
30 June,	Thursday,	Examination for Admission.
1, 2 July,	Friday, Sat.,	
		Summer Vacation of eleven weeks.
13, 14 Sept.	Tues., Wedn.,	Examination for Admission.
15 Sept.	Thursday,	First Term begins.
22 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

CORPORATION.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY CHARLES B. ANDREWS, LL.D., LITCHFIELD.

HIS HONOR DAVID GALLUP, PLAINFIELD.

REV. LEONARD BACON, D.D., LL.D., NEW HAVEN.

REV. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.

REV. HIRAM P. ARMS, D.D., NORWICH TOWN.

REV. GEORGE J. TILLOTSON, M.A., WETHERSFIELD.

HON. ALPHONSO TAFT, LL.D., CINCINNATI, O.

REV. AMOS S. CHESEBROUGH, M.A., DURHAM.

REV. MYRON N. MORRIS, M.A., WEST HARTFORD.

HON. WILLIAM M. EVARTS, LL.D., NEW YORK CITY.

HON. WILLIAM B. WASHBURN, LL.D., GREENFIELD, MASS.

REV. SAMUEL G. WILLARD, M.A., COLCHESTER.

HON. HENRY B. HARRISON, M.A., NEW HAVEN.

REV. JOSEPH W. BACKUS, M.A. ROCKVILLE.

REV. CHARLES RAY PALMER, M.A., BRIDGEPORT.

REV. JOSEPH H. TWICHELL, B.A., HARTFORD.

HON. WILLIAM WALTER PHELPS, M.A., NEW YORK CITY.

MASON YOUNG, M.A., NEW YORK CITY.

SECRETARY.

FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

v. NOAH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

ORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

LLIAM A. NORTON,
Civil Engineering. (34 N. S. H.) 72 Prospect st.

ESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

LLIAM D. WHITNEY,
Linguistics and French. (205 D.) 246 Church st.

ORGE J. BRUSH,
Mineralogy. (3 S. H.) 14 Trumbull st.

MUEL W. JOHNSON,
Theoretical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

LLIAM H. BREWER,
Agriculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

IN E. CLARK,
Mathematics. 29 Eld st.

NIEL C. EATON,
Botany. (41 N. S. H.) 70 Sachem st.

OMAS R. LOUNSBURY,
English. 22 Lincoln st.

ANCIS A. WALKER,
Political Economy and History. 68 Whitney av.

AR D. ALLEN,
Analytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

DISON E. VERRILL,
Zoölogy and Geology. (15 P. M.) 148 College st.

NEY I. SMITH,
Comparative Anatomy. (14 P. M.) 148 College st.

LLIAM G. MIXTER,
Chemistry. (8 S. H.) 8 Trumbull st.

JAY DUBOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

LECTURERS, INSTRUCTORS AND ASSISTANTS

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 27 Eld st.

MARK BAILEY,
Elocution. (105 P.) 200 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

JOSEPH J. SKINNER,
Mathematics and French. 176 York st.

JOSEPH F. KLEIN,
Kinematics and Machine Design. (45 N. S. H.) 14 Whalley av.

GEORGE W. HAWES,
Mineralogy and Lithology. (2 P. M.) 116 High st.

JAMES F. COLBY,
Political Economy. Room 10, 179 Church st.

ALLEN B. HOWE,
Analytical Chemistry. 138 College st.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (13 S. H.) 95 Humphrey st.

WILLIAM J. COMSTOCK,
Analytical Chemistry. 167 Crown st.

GRADUATE STUDENTS.

ı Atwater, B.A.	*Brattleboro, Vt.*	34 S. M.
ark Ballard, PH.B.	*Louisville, Ky.*	92 W.
ıeroy Bartlett, PH.B.	*New Britain,*	16 S. H.
ne Bruner, B.A. on College.	*Abingdon, Ill.*	169 Temple st.
Sumner Burt, litary Academy, oint.	*Marquette, Mich.*	114 College st.
ıborn Carrington, PH.B.	*New Haven,*	527 Chapel st.
Tames Comstock, PH.B.	*Toledo, O.*	167 Crown st.
vard Cromwell, PH.B.	*Cranford, N. Y.*	6½ York sq.
len Hazen, M.A. ıuth College.	*New Haven,*	298 Chapel st.
Hale Herrick, M.A. ıs College.	*Grinnell, Iowa,*	90 Whalley av.
lwards Hooker, B.A.	*New Haven,*	62 Prospect st.
Forest Hutchison, B.A.	*Norwich,*	464 Chapel st.
rae Ingersoll, PH.B.	*New Haven,*	85 Trumbull st.
rederick Klein, D.E.	*New Haven,*	14 Whalley av.
Franklin Koons, B.A. ı College.	*Sulphur Springs, O.*	36 Court st.
Valdron Lambert, B.A.	*New York City,*	90 High st.
cCormick, B.A. ln College, Ind.	*Franklin, Ind.*	215 York st.
Porter, PH.B.	*Hartford,*	14 S. H.
: Sumner Smith, B.A.	*New Haven,*	78 Trumbull st.
langs Smith, M.D.	*Westville,*	Westville.

GRADUATE STUDENTS, 20.

SENIOR CLASS.

Charles Francis Adams,	*Jessups, Md.*	36 Elm st.
Ethan Allen Andrews,	*Tarrytown, N. Y.*	175 Temple st.
Edward Bailey, Jr.,	*Harrisburg, Pa.*	489 Chapel st.
Frank Lewis Bigelow,	*New Haven,*	278 Orange st.
George Frederick Bosworth,	*Milford.*	94 Olive st.
Lester Paige Breckenridge,	*Westfield, Mass.*	6½ York sq.
Charles Sheldon Burnham,	*Woodbridge,*	Watson st.
Charles Monroe Carpenter, Jr.,	*Brooklyn, N. Y.*	134 College st.
Howard Field Chappell,	*Chicago, Ill.*	36 Elm st.
George Strong Daniels,	*New York City,*	73 W.
Charles Manville Downs,	*New Haven,*	70 Wooster st.
John Slade Ely,	*New York City,*	71 W.
George Sherman Folsom,	*Northford,*	161 George st.
Seymour Francis Frasick,	*Hartford,*	99 Wall st.
Albert Moses Gerstle,	*Youngstown, O.*	6 Orange st.
Henry Holbrook Gladding,	*New Haven,*	170 Martin st.
William Loomis Griswold,	*Banksville,*	173 Whalley av.
Frederic Jonathan Hiller,	*Cohoes, N. Y.*	71 W.
Samuel Higgins,	*Buffalo, N. Y.*	85 W.
Blain Jamison,	*New Orleans, La.*	489 Chapel st.
Jeme Tien Yow,	*Canton, China,*	44 Elm st.
Edmund Parker Lord,	*Saxonville, Mass.*	86 W.
Richard Becker Lyon,	*New Haven,*	710 Chapel st.
Silas Metzger,	*New Haven,*	17 Grove st.
Edwin Kirtland Morse,	*Poland, O.*	49 Crown st.
Marcus Daty Munn,	*Southington,*	173 Whalley av.
Marvin Olcott,	*Corning, N. Y.*	86 W.
Owyang Keng,	*Canton, China,*	169 Temple st.
Francis Stuyvesant Peabody,	*Chicago, Ill.*	36 Elm st.
Oliver Phelps,	*Canandaigua, N. Y.*	92 W.
Addison Alexander Righter,	*Newark, N. J.*	73 W.
George Lewis Sargent,	*New Haven,*	51 Elm st.
Louis Jacob Schiller,	*New Haven,*	8 Martin st.
Bernard Joseph Shanley,	*New Haven,*	211 Franklin st.
Frank Augustus Smith,	*New Haven,*	36 Lyon st.
Henry Taber,	*New York City,*	[illegible]
John Heyward Trumbull,	*Talcahuano, Chili,*	41 Trumbull st.
Richard Lindsay Trumbull,	*Talcahuano, Chili,*	41 Trumbull st.
Howard VanRensselaer,	*Albany, N. Y.*	23 Prospect st.
Frank Charles Warner,	*West Suffield,*	116 College st.
Robert William Watson,	*Ashtabula, O.*	489 Chapel st.
William Meeker Wood,	*Morristown, N. J.*	489 Chapel st.
Arthur Burnham Woodford,	*West Winsted,*	116 College st.
Clark Wright,	*West Roxbury, Mass.*	82 Wall st.
Willis Benton Wright,	Cromwell,	88 Grove st.

JUNIOR CLASS.

Ellsworth Andrews,	*Cleveland, O.*	43 College st.
Jackson Angell,	*Brooklyn, N. Y.*	43 College st.
Warren Armstrong,	*Cleveland, O.*	43 College st.
Noyes Batcheller,	*Wallingford, Vt.*	6½ York sq.
Jonathan Biddle,	*Philadelphia, Pa.*	36 Elm st.
Hayes Blake,	*New Haven,*	Mill Rock.
Gross Bozeman,	*New York City,*	196 Crown st.
k Casper,	*West Meriden,*	529 Chapel st.
Chamberlain,	*Brooklyn, N. Y.*	489 Chapel st.
Anson Chamberlin,	*New Haven,*	30 Trumbull st.
g Chun,	*Canton, China,*	44 Elm st.
Henry Crocker,	*San Francisco, Cal.*	36 Elm st.
Loot Downs,	*New Haven,*	64 LaFayette st.
ohn Drummond,	*Winfield, Ill.*	6½ York sq.
Ogden DuBois,	*New Haven,*	328 Howard av.
Mortimer Dunham,	*Unionville,*	109 Elm st.
Lawrence Everit,	*New Haven,*	281 Whitney av.
Waldron Faulkner,	*Stamford,*	233 York st.
Alanson Hall,	*Morris,*	95 Wooster st.
er Bryan Johnson,	*Utica, N. Y.*	83 w.
Deatherage Lacey,	*Brooklyn, N. Y.*	36 Elm st.
k William La Forge,	*Waterbury,*	6½ York sq.
udson Lambert,	*New Haven,*	12 Eld st.
Smith Latham,	*North Manchester,*	120 Dwight st.
Samuel Lyman,	*Holyoke, Mass.*	25 Prospect st.
el White Lynde,	*West Brookfield, Mass.*	6½ York sq.
Danforth MacQuesten,	*Washington, D. C.*	167 Temple st.
Elton Minor,	*Thomaston,*	167 Temple st.
to Okabe,	*Tokio, Japan,*	92 Grove st.
E. Paramore,	*St. Louis, Mo.*	36 Elm st.
alentine Pirsson,	*New York City,*	121 Park st.
mith Pope,	*Jersey City, N. J.*	61 w.
dward Pope, Jr.,	*Jersey City, N. J.*	61 w.
itchinson Robinson,	*Lake Village, Ark.*	215 York st.
Browning Rood,	*Great Barrington, Mass.*	167 Temple st.
Edward Stockder, Jr.,	*West Meriden,*	6½ York sq.
ore Strong,	*Chicago, Ill.*	36 Elm st.
Graham Thompson,	*Milford,*	43 College st.
Thorne,	*New York City,*	65 Whitney av.
Pearsall Thorne,	*Millbrook, N. Y.*	65 Whitney av.
Joy Vought,	*Buffalo, N. Y.*	85 w.
Loder Whittemore,	*Rye, N. Y.*	76 w.
Buckingham Willcox,	*Chicago, Ill.*	76 w.
y Pratt Williams, Jr.,	*Albany, N. Y.*	36 Elm st.
ence Williams,	*Chicago, Ill.*	36 Elm st.
k Wing,	*China,*	44 Elm st.

JUNIORS, 46.

FRESHMAN CLASS.

Paul Whitin Abbott,	*New Haven,*	257 Church st.
Gustavo Alfonso,	*New York City,*	88 Wall st.
John Alpheus Allen,	*New Haven,*	189 Temple st.
Theodore Davenport Bacon,	*Norwich,*	247 Church st.
Benjamin Safford Barrows,	*Hartford,*	128 High st.
George Andrew Barrows,	*Philadelphia, Pa.*	114 College st.
Henry Dudley Barry,	*Constantine, Mich.*	29 Prospect st.
John Bartholomew,	*Guilford,*	15 Wooster pl.
Frederic Robinson Bartlett,	*Freeport, Ill.*	192 York st.
Frederick Elijah Beach,	*New Haven,*	33 Lyon st.
Henry Whitney Berryman,	*New York City,*	117 York st.
William Williams Bond,	*New London,*	33 Prospect st.
Isaac Judson Boothe,	*Birmingham,*	84 Wall st.
Charles Allan Bowles,	*Springfield, Mass.*	94 Grove st.
Frederick Truman Bradley,	*New Haven,*	142 Orange st.
Charles Parker Breese,	*Meriden.*	529 Chapel st.
Charles Sumner Brown,	*East Hampton,*	12 Trumbull st.
Charles Milo Carpenter,	*Madison, Wisc.*	167 Temple st.
Horace Raymond Carpenter,	*Afton, N. Y.*	162 York st.
Fred Willis Chapman,	*Chico, Cal.*	82 Wall st.
Samuel Myron Chase,	*Chicago, Ill.*	184 York st.
Harry Nelson Covell,	*Stamford,*	200 York st.
Wayne Darlington,	*West Chester, Pa.*	120 High st.
Edward Bradford Dench,	*Bridgeport,*	18 E.
Henry Kelsey Devereux,	*Cleveland, O.*	55 Trumbull st.
Edward Peers Eastwick, Jr.	*New York City,*	192 York st.
Frank Hynard Edsall,	*Hamburgh,*	128 High st.
Horatio Southworth Frazer,	*Holyoke, Mass.*	134 College st.
Harry Brainard Gaylord,	*New Haven,*	40 Academy st.
Charles Lockwood Gold,	*West Cornwall,*	49 Grove st.
Charles Stewart Hall,	*Warren, O.*	49 Grove st.
George Vance Harper,	*Sing Sing, N. Y.*	82 Wall st.
William Harper,	*Shippensburg, Pa.*	82 Wall st.
William Howard Hart,	*New Haven,*	82 Trumbull st.
Allen Hubbard,	*Westfield, Mass.*	6¼ York sq.
Arthur Henry Jackson,	*New Haven,*	12 Warren st.
Henry Clay Johnson,	*Rome, Ga.*	153 Crown st.
Wylie Brantley Jones,	*New Haven,*	89 Wooster st.
Tsu Ye Ki,	*Shanghai, China,*	144 High st.
William Klein,	*New Haven,*	86 Nicoll st.
John Elmer Lockwood,	*Stamford,*	146 Dixwell av.
William Ellison Lockwood,	*Stamford,*	146 Dixwell av.
James Lyman,	*Middlefield,*	107 W.
John Lyman,	*Middlefield,*	107 W.
George Smith Hunt McDowell,	Portland, Me.	33 Prospect st.

y Mann,	*Utica, N. Y.*	116 w.
ant Mitchell, Jr.	*Edgewood,*	84 Wall st.
kwell Morgan,	*Glastonbury,*	187 Temple st.
ınd Newell,	*Chicago, Ill.*	464 Chapel st.
tis Nutt,	*Chicago, Ill.*	489 Chapel st.
ɔner Parrott,	*Bridgeport,*	36 Elm st.
pman Payson,	*Chicago, Ill.*	464 Chapel st.
ells Penfield.	*Chicago, Ill.*	94 Grove st.
doch Pratt,	*Elmira, N. Y.*	198 Crown st.
rman Randall,	*Birmingham,*	72 High st.
nlet,	*Holyoke, Mass.*	134 College st.
lliam Robert,	*New York City,*	237 Orange st.
ırren Rogers, Jr.	*Scarborough, N. Y.*	82 Wall st.
ghes Rowe,	*Fair Haven,*	Fair Haven.
Baylies Samson,	*Richmond, Ind.*	165 Temple st.
nsing Sayre,	*Utica, N. Y.*	116 w.
e Simpson,	*Pensacola, Fla.*	198 Crown st.
Hubbard Skinner,	*Escambia, Fla.*	198 Crown st.
len Skinner,	*Holyoke, Mass.*	146 College st.
ving Stone,	*Bethlehem,*	365 Orchard st.
ards Stryker,	*Catskill, N. Y.*	29 Prospect st.
worth Thompson,	*St. Louis, Mo.*	55 Trumbull st.
dgway VanBlarcom,	*Cornwall, N. Y.*	88 Wall st.
lton Wood, Jr.	*West Haven,*	77 George st.
Wurts,	*New Haven,*	65 Whitney av.
wthorne Wylie,	*Chester, S. C.*	258 Orange st.

FRESHMEN, 71.

CIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

ı Buruaga,	*Santiago, Chili,*	258 Orange st.
ley Coates,	*Kansas City, Mo.*	66 w.
ward Sanford,	*Bridgeport,*	494 Chapel st.
ıgler,	*Ansonia,*	Ansonia.
in Slavens,	*Kansas City, Mo.*	66 w.
. Spalding,	*New Haven,*	89 Church st.
radbury Spring,	*Portland, Me.*	36 Elm st.
letcher Stone,	*New Haven,*	143 Lamberton st.
etit Trowbridge, Jr.	*New Haven,*	82 Prospect st.

SPECIAL STUDENTS, 9.

SUMMARY.

Graduates,	20
Seniors,	45
Juniors,	46
Freshmen,	71
Special,	9
Total,	191

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction d researches in the mathematical, physical, and natural sciences, ıth reference to the promotion and diffusion of science, and also the preparation of young men for such pursuits as require pecial proficiency in these departments of learning. It is one of ıe Departments of Yale College, like the law, medical, theologi-ıl, and art schools, having its separate funds, buildings, teachers, ıd regulations, but governed by the Corporation of Yale Col-ge, which appoints the professors and confers the degrees. It , in part, analogous to the academic department, or classical col-ge, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons ualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical ıd scientific, in less part linguistic and literary, for higher scien-ific studies, or for various other occupations to which such raining is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient uilding and a considerable endowment were given by Joseph E. heffield, Esq., of New Haven, whose name at the repeated equest of the Corporation of Yale College, was afterward ttached to the foundation. Mr. Sheffield has since frequently nd munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national rant for the promotion of scientific education (under the con-ressional enactment of July, 1862) was given to this department f Yale College. Since that time, and especially since the autumn f 1869, *numerous liberal gifts* have been received from the citi-

zens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

Maps and Charts, topographical, hydrographical, geological, etc.

he herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. *This degree* is conferred upon those who, hav-

ing already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter time, *to graduate* students who do not desire to become candidates for *a degree.*

Students who have taken the degree of Bachelor of Philosophy, y obtain the degree of CIVIL or of DYNAMIC ENGINEER at the l of two academical years, by pursuing the following higher rse of study and professional training.

The course of study for the degree of CIVIL ENGINEER will nprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and ctice, the candidate will be required to furnish a comprehensive ort of the results of an examination into the existing condition some special line of constructive art; or to present proper evi- nce that he has had actual charge in the field, for several months, construction or surveying parties, or held some responsible sition deemed equivalent to this.

An elaborate design must also be submitted of some projected rk of construction, based upon exact data obtained from care- surveys made by the candidate, and comprising all the requi- e calculations, and the necessary detailed drawings, and accom- nied by full specifications of the work to be done, and the quirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will mprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ ch a portion of their time as may be deemed advisable or neces- ry in the examination of engineering works and manufacturing tablishments, and may also have the privilege of entering upon ofessional practice, provided it is done with the knowledge and nsent of the Professor of Dynamic Engineering, and under such rcumstances as shall appear to him to be favorable to profes- onal progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid and spherical; including fundamental notions of symmetry, and examples of loci and of maxima and minima of plane figures:—an equivalent of the nine books of Chauvenet's Treatise, or of the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions, and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15th.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat, orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the requirement, the following works are specifically named, among *which the candidate for* examination may make his own selection,

These are Harkness's "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 30, July 1, 2, and on Tuesday and Wednesday, September 13, 14, 1881. Opportunity for private examinations may, in exceptional cases, be given at other times.

In 1881 examinations (for the Freshman Class only) will also be held in Chicago and in Cincinnati (beginning on Thursday, June 30, at 9 A. M.), at a place to be announced in the local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to these examinations.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in Composition. *Mathematics*—Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory Practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical problems. Geology—Dana's. *Mineralogy—Blowpipe Analysis* and Determinative Mineralogy. French.

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe Connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurements of Water Supply; Discharge of Pipes. *Thermodynamics*—General principle of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Physiology*—Huxley's. *Botany*—Lectures. French. *German.*

SENIOR YEAR:

RST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern s. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Or-* : *Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Zoology*. *English*. *ch*.

COND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; ures. *Geology* — Dana's. *Rural Economy* — History of Agriculture and ches of Husbandry in Foreign Countries; Systems of Husbandry. *Agricul-* *Chemistry*—Johnson's. *Geology*—Dana's. *Zoology*. *Botany*. *Microscopy*. *ish*. *French*.

(e.) IN NATURAL HISTORY.

ither Geology, Mineralogy, Zoology, or Botany, may be made the principal y, some attention in each case being directed to the other three branches of ural History.)

JUNIOR YEAR:

IRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recita- s. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany* ray's Manual; Laboratory Practice. *German*. *French*.

ECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *eralogy*—continued. *Physical Geography*. *German*. *French*.

SENIOR YEAR:

IRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; tures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Text- k; Excursions. *French*.

ECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology* aboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, ecially in the Cryptogamous Orders; Botanical Literature; Essays in Descrip- Botany. *Meteorology*. *French*.

esides the regular courses of recitations and lectures on structural and sys- atic Zoology and Botany, and on special subjects, students are taught to pre- e, arrange, and identify collections, to make dissections, to pursue original estigations, and to describe genera and species in the language of science. these purposes, large collections in Zoology and Palæontology belonging to College are available, as are also the private botanical collections of Professor ton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. Qualitative alysis—Fresenius's; *Laboratory* Practice; Recitations. Mineralogy—Blow- e *Analysis and Determinative* Mineralogy. *German*. *French*.

SECOND TERM—*Physiology*—Huxley's, with Practical Exercises. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiologic Chemistry*—Sanderson's Handbook; Recitations and Laboratory Work. *Mineralogy* — continued. *Botany* — Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil and Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *History*—Constitutional History of the United States; Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English* — Shakspere, Milton, Dryden, Pope, and later authors. *History*—Political History of U. S.; History of Europe from 1848; Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduation theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of *Flowering Plants, Ferns,* Mosses, Algæ, etc. In the autumn

term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological laboratory, for materials and use of instruments. An additional charge of $5 is *annually* made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 17–18.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 15, 1881. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDE

The scholarships established in this School in consequen the bestowal upon it of the Congressional grants are design aid young men who are in need of pecuniary assistance in fi themselves for agricultural and mechanical pursuits of life. applicants must be citizens of Connecticut. In case there are applicants than vacancies, candidates will be preferred who lost a parent in the military or naval service of the United St and next to these such as are most in need of pecuniary a ance; and the appointments will be distributed as far as p cable among the several counties in proportion to their popula The appointing Board for the current year, consisting of the B of Visitors of the State and the Secretary of the School, will on June 28th, 1881, and at or about the same time in the 1882, due notice of which will be given by publication in e county of the State. All applications should be made pre to that time. Blank forms for application will be sent, requested, by Professor GEORGE J. BRUSH, Secretary of Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of Commencement week in Yale College, when selections from graduation theses are publicly read. The degrees are pub conferred by the President and Fellows of Yale College on mencement Day.

APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1880, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JULY, 1880.

1. (*a*) Select the prime numbers between 1 and 50.
   (*b*) Find the prime factors of 6902.

2. Find the value of $\frac{4\frac{1}{7} - 2\frac{1}{4}}{6\frac{1}{2} - 2\frac{1}{7}}$, in its simplest form.

3. Divide 0.10724 by 0.003125.

4. How many stones 10 inches long, 9 inches broad, and 4 inch thick, would it require to build a wall 80 feet long, 20 feet hig and $2\frac{1}{2}$ feet thick, without mortar?

5. The population of a certain town has gained 25 per cer within the last five years. It is now 6575; what was it five yea ago?

6. Extract the square root of 3369 to three places of decima

7. Give the approximate value of the meter in inches; of t gram in grains; of the kilogram in pounds avoirdupois; of t liter in liquid quarts.

What is the weight of a liter of pure water at its maximu density?

ARITHMETIC.

SEPTEMBER, 1880.

1. Reduce $\frac{3}{9\frac{1}{10}}$ and $\frac{7}{24\frac{7}{10}}$ to their least common denominato add the results, and express the sum decimally to four places.

2. If 8 horses consume $3\frac{1}{2}$ tons of hay in 30 days, how long w $4\frac{8}{10}$ tons last 10 horses?

3. A buys 9 per cent. stocks at 25 per cent. premium; and buys 6 per cent. stocks at 25 per cent. discount: supposing di dends to be paid promptly, what rates of interest will they recei on their investments?

4. Calculate the square root of 2.064 to two places of decima

5. Calculate the cube root of 3.3 to two places of decimals.

6. How many hectoliters of grain will a bin hold whose interi length, width, and depth, are each 6 ft. 6 in.

GEOMETRY.

JULY, 1880.

[State what text-book you have studied and to what extent.]

I.—PLANE GEOMETRY.

1. (*a*) Define the symmetry of a figure with respect to an axis and with respect to a point.

(*b*) Prove that if a figure is symmetrical with respect to two axes perpendicular to each other, it is also symmetrical with respect to the intersection of these axes.

2. An angle formed by a tangent and a chord is measured by one-half the intercepted arc.

2. To bisect a given arc or angle.

4. (*a*) If a perpendicular be drawn from the vertex of the right angle to the hypothenuse of a right triangle, the two triangles thus formed are similar to each other and to the whole triangle.

(*b*) What can you say of the perpendicular as compared with the segments of the hypothenuse? Why?

(*c*) What, of either side about the right angle? Why?

5. On a given straight line to construct a polygon similar to a given polygon.

6. The circumferences of two circles are to each other as their radii, and their areas are to each other as the squares of their radii.

II.—SOLID AND SPHERICAL GEOMETRY.

7. If a straight line and a plane are parallel, the intersection of the plane with planes passed through the line are parallel to that line and to each other.

8. Define a prism. Two prisms are equal, if three faces including a triedral angle of the one are respectively equal to three faces similarly placed including a triedral angle of the other.

9. Every section of a sphere made by a plane is a circle.

10. Between what two limits does the sum of the angles of a spherical triangle lie? Write expressions for the surface and volume of the cylinder, cone and sphere.

NOTE.—Candidates who present themselves for the whole examination may omit questions 2, 3 and 5. Candidates who present themselves for the partial examination will confine themselves to the questions in Plane Geometry.

GEOMETRY.

SEPTEMBER, 1880.

[State what text-book you have studied and to what extent.]

1. To draw a common tangent to two given circles.

2. The bisector of an angle of a triangle divides the opposite side into segments which are proportional to the adjacent sides.

3. The area of a parallelogram is equal to the product of its base and altitude.

4. How do you find the area of a trapezoid? The areas of similar polygons are to each other in what ratio? Of all plane figures having the same area what one has the least perimeter?

5. If a straight line is perpendicular to each of two straight lines at their point of intersection, it is perpendicular to the plane of those lines.

6. A triangular pyramid is one-third of a triangular prism of the same base and altitude.

7. Define the terms *spherical excess*, and tri-rectangular triangle. The area of a spherical triangle is equal to its spherical excess (the right angle being the unit of angles and the tri-rectangular triangle the unit of areas).

ENGLISH.

JULY, 1880.

1. Parse the words in the following sentences:

(*a*) Many were present who had no desire to change.

(*b*) The wages of sin is death.

2. Name the parts of speech, with an illustrative example of each one.

3. Inflect throughout the pronouns of the first and second persons.

4. Give the principal parts of the verbs *lie*, *lay*, *draw*, *ride*, *thrive*, *set*, *sit*, and *go*.

ALGEBRA.

JULY, 1880.

[State what text-book you have studied and to what extent.]

1. Resolve the following expressions into factors:
$16a^4b^2-24a^2bmx+9m^2x^2$; $9a^2b^2-16a^2c^2$; a^3-8b^3.

2. Given $\frac{x}{a+b}+\frac{y}{a-b}=\frac{1}{a-b}$ and $\frac{x}{a+b}-\frac{y}{a-b}=\frac{1}{a+b}$; find x and y.

3. Given $\sqrt{a-x}+\sqrt{b-x}=\frac{b}{\sqrt{b-x}}$ to find x.

4. (1) From $2\sqrt{72a^2}$ take $\sqrt{162a^2}$.
(2) Find the value of $\sqrt{2}\times\sqrt[3]{3}\times\sqrt[4]{5}$.
(3) Divide $8a-b$ by $2a^{\frac{1}{3}}-b^{\frac{1}{3}}$.
(4) Simplify $\frac{a^2b}{3c}\left(\frac{a^7b^4}{9c^5}\right)^{-\frac{1}{4}}$.

5. Given $\frac{3x}{2}+4x-8>3$ and $6x+\frac{5x-15}{3}<18$ to find a superior and an inferior limit of x.

II.

6. Given $\frac{x+2}{x-2}-\frac{x-2}{x+2}=\frac{5}{6}$, to find the values of x.

7. Given $x^2+xy=a$, $y^2+xy=b$, to find x and y.

8. Expand $\frac{1+2x}{1-x-x^2}$ into a series by the method of indeterminate coefficients.

9. The number of permutations of n things, 3 together, is 6 times the number of combinations, 4 together; find n.

NOTE.—The first division of the paper extends as far as Quadratic Equations, and will be all that is required of candidates who propose to pass the partial examination only.

ALGEBRA.

SEPTEMBER, 1880.

1. Divide $\frac{x^4 - b^4}{x^2 - 2bx + b^2}$ by $\frac{x^2 + bx}{x - b}$.

2. Given $\frac{a+4b}{m+x} = \frac{2a-3b}{3m-y}$ and $5ax - 2by = c$ to find x and y.

3. $\sqrt{14-x} + \sqrt{11-x} = \frac{3}{\sqrt{11-x}}$ to find x.

4. Simplify $\sqrt{24} + \sqrt{54} - \sqrt{6}$; $\frac{a+b}{a-b}\sqrt{\frac{a-b}{a+b}}$;

$a\sqrt[n]{x} \times b\sqrt[n]{y} \times c\sqrt[n]{z}$; $(\sqrt{-1})^4$; $(\sqrt[4]{-1})^2$.

5. Extract the square root of $4x^4 + 16a^4 - 12ax^3 - 24a^3x + 25a^2x^2$.

6. Solve the equation $3x^2 + 2x - 9 = 76$.

7. If $\frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3} \ldots = \frac{a_n}{b_n} = r$, show that

$$\frac{a_1 + a_2 + a_3 + \ldots + a_n}{b_1 + b_2 + b_3 + \ldots + b^n} = r.$$

8. Having the first term (a), the ratio (r), and the last term (l), of a geometric progression, find the sum (s) and the number (n) of the terms.

9. Expand $\frac{b}{\sqrt{x^2+a^2}}$ into a series by the binomial formula.

10. Solve the equations $x^y = y^x$, and $x^2 = y^3$.

TRIGONOMETRY.

JULY, 1880.

[State what text-book you have studied and to what extent.]

1. Given $\tan A = \sqrt{3}$; find all the other functions of A when A an angle of the 3d quadrant.

2. Given $\sin 30° = \frac{1}{2}$; find the sine and cosine of $\pm 60°$, 120°, 150°, 210°, 240°, 300°, 330°.

3. Deduce the formula $\sin x + \sin y = 2 \sin \frac{1}{2}(x+y) \cos \frac{1}{2}(x-y)$.

4. Show that $\tan^{-1} x - \tan^{-1} y = \tan^{-1} \frac{x-y}{1+xy}$.

5. Write the formulæ for solving the several cases of right angles.

6. In a plane triangle the side b is 304, the side c 280.3 and the included angle A is 100°. Find the remaining parts.

TRIGONOMETRY.

SEPTEMBER, 1880.

[State what text-book you have studied and to what extent.]

1. The length of an arc is 1.5 that of its radius; what is the number of degrees in the angle it subtends?

2. Find all of the functions of the following angles:

$$\pm 45°, 135°, 225°, 315°.$$

3. Given $\sin A = m \sin B$ and $\tan A = n \tan B$; find $\sin A$ and $\sin B$.

4. Deduce the formulæ for the sine of the sum of two angles in terms of the sines and cosines of the angles.

5. Given $A = \sin^{-1} \frac{3}{5}$, $B = \sin^{-1} \frac{4}{5}$, to show that $A + B = 90°$.

6. In a triangle A B C, given $a = 309$, $b = 450$, and $A = 27° 50'$, first determine whether the triangle admits of more than one solution, and then solve it.

LATIN.

JULY, 1880.

I. Translate as literally as possible—

a. Quum ea ita sint, tamen, si obsides ab iis sibi dentur, uti ea, quae pollicentur, facturos intelligat, et si *Aeduis* de injuriis, quas ipsis sociisque eorum intulerint, item si Allobrogibus satisfaciant, sese cum iis pacem esse facturum. Divico respondit: Ita Helvetios a majoribus suis institutos esse, uti obsides accipere, non dare, consuerint; ejus rei populum Romanum esse *testem*.

b. Ibi vadis repertis partem suarum copiarum transducere conati sunt, eo consilio, uti, si possent, castellum, *cui* praerat Quintus Titurius legatus, expugnarent, pontemque interscinderent; si minus potuissent, agros Remorum popularentur qui magno *nobis usui* ad bellum gerendum erant, commeatuque nostros prohiberent.

c. Impeditis hostibus propter ea, quae ferebant, onera, subito quabus *portis* eruptionem fieri jubet. Factum est opportunitate loci, hostium inscientia ac defatigatione, virtute militum, et superiorum pugnarum *exercitatione*, ut ne unum quidem nostrorum impetum ferrent ac statim terga verterent.

d. Dum in his locis Caesar *navium* parandarum causa moratur, ex magna parte Morinorum ad eum legati venerunt, qui se de superioris temporis consilio excusarent, quod homines barbari et nostrae *consuetudinis* imperiti bellum populo Romano fecissent, seque ea, quae imperasset, facturos pollicerentur.

e. Britanniae pars interior ab iis incolitur, quos natos in insula ipsi memoria *proditum* dicunt; maritima pars ab iis, qui praedae ac belli *inferendi* causa ex Belgis transierant; qui omnes fere iis nominibus civitatum appellantur, quibus orti ex civitatibus eo pervenerunt, et, bello illato, ibi permanserunt atque agros colere coeperunt.

f. Ambiorix copias suas *judicione* non conduxerit, quod proelio dimicandum non existimarit, an tempore exclusus et repentino equitum adventu prohibitus, quum reliquum *exercitum* subsequi crederet, dubium est; sed certe dimissis per agros nuntiis sibi quemque consulere jussit.

II. 1. Decline *obsides* (1), *majoribus* (5), *loci* (16).

2. Compare *imperiti* (22), *interior* (24), *certe* (33).

3. Write the synopsis, active and passive, of *intelligat* (2).

4. State the mood and tense of the following: *consuerint* (6), *praerat* (9), *ferrent* (18), *imperasset* (23), *existimarit* (31).

5. Give the principal parts of the following: *polliceantur* (2), *repertis* (8), *interscinderent* (10–11), *gerendum* (12), *verterent* (18), *incolitur* (24), *orti* (28), *colere* (29), *existimarit* (31), *exclusus* (31), *crederet* (33), *consulere* (34).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (oratio directa) the example quoted in answer to question seventh.

LATIN.

SEPTEMBER, 1880.

I. Translate as literally as possible—

a. Eadem secreto ab aliis quaerit; reperit esse vera: Ipsum esse Dumnorigem, summa *audacia*, magna apud plebem propter liberalitatem gratia, cupidum rerum novarum: complures *annos* portoria reliquaque omnia Aeduorum vectigalia parvo *pretio* redempta habere, propterea quod, illo licente, contra liceri audeat nemo.

b. Quum ab his quaereret, quae civitates, quantaeque in armis essent et *quid* in bello possent, sic reperiebat: Plerosque Belgas esse ortos ab Germanis, Rhenumque antiquitus transductos propter loci fertilitatem ibi consedisse, Gallosque, qui ea loca incolerent, expulisse.

c. His rebus gestis, quum omnibus de cansis Caesar pacatam Galliam existimaret, superatis Belgis, expulsis Germanis, victis in Alpibus Sedunis, atque ita inita *hieme* in Illyricum profectus esset, quod eas quoque *nationes* adire et regiones cognoscere volebat, subitum bellum in Gallia coortum est.

d. Germanico bello confecto, multis de causis Caesar statuit *sibi* Rhenum esse transeundum; quarum illa fuit justissima, quod, quum videret Germanos tam facile impelli, ut in Galliam venirent, suis quoque *rebus* eos timere voluit, quum intelligerent et posse et audere populi Romani *exercitum* Rhenum transire.

e. Utuntur aut *aere* aut taleis ferreis ad certum pondus examinatis pro nummo. Nascitur ibi plumbum album in mediterraneis regionibus, in maritimis *ferrum*, sed ejus *exigua* est copia; aere utuntur importato. Materia cujusque generis, ut in Gallia, est, praeter fagum atque abietem.

f. Ac fuit antea tempus, quum Germanos Galli *virtute* superarent, ultro bella inferrent, propter hominum multitudinem agrique inopiam trans Rhenum colonias mitterent. Itaque ea, quae fertilissima Germaniae sunt, loca circum Hercyniam silvam, Volcae Tectosages, occupaverunt atque ibi consederunt.

II. 1. Decline *vectigalia* (4), *ea* (11), *hieme* (14).

2. Compare *parvo* (4), *facile* (20), *fertilissima* (31).

3. Write the synopsis, active and passive, of *habere* (5).

4. State the mood and tense of the following: *reperit* (1), *audeat* (6), *videret* (20), *superarent* (28–29), *inferrent* (29).

5. Give the principal parts of the following: *quaerit* (1), *reperit* (1), *audeat* (6), *incolerent* (11), *coortum* (16), *confecto* (17), *impelli* (20), *videret* (20), *intelligerent* (21), *nascitur* (24), *consederunt* (32).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (*oratio directa*), the example quoted in answer to question seventh.

LATIN EXERCISES.

JULY, 1880.

1. The Helvetians[1] move[2] (their) camp[3] from[4] this[5] place[6].
2. Cæsar does[7] the same[8] (thing).
3. Cæsar sends-forward[9] all[10] (his) cavalry[11].
4. The cavalry was sent-forward by[12] Cæsar.
5. Cæsar will move (his) camp and[13] send-forward all (hi cavalry.
6. The Helvetians having moved (their) camp[14], Cæsar did t same (thing).
7. Cæsar said[15] he would move his camp.
8. (Rewrite sentence seventh so as to illustrate direct statemen
9. The Helvetians say: "The Roman[16] people[17] is a witness'
10. (Rewrite sentence ninth so as to illustrate indirect statemen

[1] Helvetius.
[2] movere.
[3] castra.
[4] ex.
[5] is.
[6] locus.
[7] facere.
[8] idem.
[9] praemittere.
[10] omnis.
[11] equitatus.
[12] a.
[13] que.
[14] use subjunctive with *quu*
[15] dicere.
[16] Romanus.
[17] populus.
[18] testis.

LATIN EXERCISES.

SEPTEMBER, 1880.

1. Labienus[1] fortifies[2] the camp[3].
2. The camp is fortified by[4] Labienus.
3. Labienus set-out[5] against[6] the enemy[7].
4. Labienus ascertained[8] the design[9] of the enemy (plural).
5. Labienus, having ascertained[10] the design of the enemy (p ral), fortifies (his) camp.
6. Labienus set-out with[11] five[12] cohorts[13].
7. Labienus said[14] he would set-out with five cohorts.
8. (Rewrite sentence seventh so as to illustrate direct statemen
9. Labienus says: "I will move[15] the camp at day-break[16]."
10. (Rewrite sentence ninth so as to illustrate indirect statemen

[1] Labienus.
[2] communire.
[3] castra.
[4] a.
[5] *proficisci.*
[6] *contra.*
[7] hostis.
[8] cognoscere.
[9] consilium.
[10] cum.
[11] quinque.
[12] cohors.
[13] dicere.
[14] movere.
[15] prima lux.
[16] use *ablative absolu*

HISTORY OF THE UNITED STATES.

JULY, 1880.

1. What territory has the United States acquired by purchase? by conquest? by annexation?

2. State the causes of (1) the French and Indian War; (2) the Revolutionary War; (3) the War of 1812.

3. Arrange the following events in the order in which they occurred, with their dates: admission of California to the Union, assembling of the first Continental Congress, acquisition of Florida, second election of Monroe, opening of the Erie Canal, capture of Atlanta, death of Daniel Webster.

4. What was the Wilmot Proviso?

5. What Vice-Presidents were afterward elected Presidents?

6. Give the names of the opposing political parties in 1800; in 1840; in 1860.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1880.

1. What territory was granted by James I. to the London Company? to the Plymouth Company?

2. Describe the settlement of Virginia.

3. Arrange the following events in the order in which they occurred, with their dates: surrender of Cornwallis, the admission of West Virginia to the Union, the Whiskey Rebellion, the negotiation of Perry's treaty with Japan, the adoption of the Constitution.

4. When and where was the Confederate Government formed?

5. What was the Compromise of 1850?

6. What President was impeached? What Presidents were elected by the Federalist party?

GEOGRAPHY.

JULY, 1880.

1. Bound the State of Mississippi; name its larger cities, a tell how they are situated.

2. Where is the Cape of Good Hope; Cape May; Cape Lucas; Cape Race?

3. What countries of America border on the Pacific Ocean?

4. Where does the River Rhine rise, run and empty; and wh countries does it touch?

5. What countries of Europe touch the Mediterranean Sea?

6. Where are the following cities: Melbourne, Milwauk Havre, Valparaiso, Cairo?

GEOGRAPHY.

SEPTEMBER, 1880.

1. Bound the State of Virginia; what are some of its lar cities, and how are they situated? and what are some of t principal rivers in it or on its borders?

2. What states (of the U. S.) border on the Gulf of Mexic name them in their order, beginning with Texas.

3. Where does the Missouri river rise? describe the direct of its course; what states and territories does it pass through touch?

4. Where are the following European cities, and how are th situated: Bremen, Venice, Cologne, Havre, Hamburgh?

5. Where are the Aleutian Islands? the Azores? the B mudas? the Philippines? the Bahamas?

6. Bound British India. Give the names of some of its pr cipal rivers, mountains, and cities, and tell how each is situat

SIXTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1881--82.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly:

The State Board of Visitors of the Sheffield Scientific School at Yale College have the honor to transmit herewith the sixteenth Annual Report of the Governing Board. We commend this document to the careful examination of the Legislature, for from it can be had acquaintance with the workings and the necessities of one of the most useful and influential educational establishments in which our State has an active interest. It will be seen that the demands upon the capacity and accommodations of the school are steadily increasing. It is in every respect conducted in a manner satisfactory to your visiting board, and we believe that it is doing its important work thoroughly well. Its importance to our practical, industrial community can hardly be overestimated. It is preparing our youth to maintain and continue that supremacy and advance in industrial pursuits of which the State is proud, and it is at the same time fostering and spreading *a love for* sound science, and the habit of

sound methods which must form the true basis for a healthy and permanent continuance of that supremacy. To it also our agricultural population have learned to look for help. In this way it has attached itself intimately with our most vital material interests, while at the same time it has been maintained as a scientific school. We believe that it is fully accomplishing its duty to the State and deserving of the care which the State has bestowed.

HOBART B. BIGELOW,
Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Sixteenth Annual Report the Governing Board has the gratification of announcing the continued prosperity of the School. The entering class fully equals that of the year preceding which was itself exceptionally large. In particular, the growing interest in science has been evinced for several years past by the increasing number of students who are desirous of receiving instruction in Chemistry. A large share of Sheffield Hall has been devoted to this special branch, but for a long while even that space has been felt to be inconveniently crowded. It will be observed that the number of special students not candidates for a degree is this year fewer than ordinarily. The reason for this is that there was no room in the Analytical Laboratory, the course in Chemistry being the one ordinarily pursued by such students. Several applications to take this course the Board were in consequence under the necessity of declining, because the facilities at their command were not sufficient to enable them to afford the instruction desired. Moreover they have this year entered into an arrangement with the Academic department to furnish instruction in the Analytical Laboratory to six students of that department who wished to take special courses in Chemistry. Application was made for a larger number but the space at the disposal of the School was not sufficient to allow of any more.

Under these circumstances the Governing Board felt themselves compelled to give notice to the Connecticut Agricultural Experiment Station that after this year the rooms occupied by it would be needed for the further extension of the Analytical Laboratory. The Experiment Station has occupied quarters in Sheffield Hall since its establishment in 1877; and were it in their power the Board would *gladly continue* to furnish as before the free use of

the rooms it has been occupying. Now that it has been determined to offer still further facilities for the study of Chemistry, it has been deemed advisable to give a full account of this course, with definite statements of its aims and a detailed account of the instruction it affords. During the past three or four years especially its course of study has been considerably modified and it is thought improved. A fuller account of it than can be found in our late annual reports may therefore be of interest to the friends of the School, and to those who are considering which of the several courses offered will best fit them for their proposed future profession or occupation.

The Chemical Course.

The chemical course was one of the first distinct courses of study organized in the School. In the earlier years of its existence, students entered it with a great diversity of aim; for besides its adaptation to the wants of the chemical student, it furnished a partial preparation for the study of agriculture, metallurgy, mining engineering, medicine, pharmacy, and perhaps other professions. The development, during the past twenty years, in the Sheffield Scientific School as well as in other institutions, of courses of study designed especially as a preparation for these professions, has undoubtedly withdrawn from this course many students who would otherwise have entered it. Its classes however have not diminished. There are still many—and the number seems to be increasing—to whom the study of chemistry as a pure science, without regard to its application to industrial pursuits, or its use in other professions, is so attractive that they decide to make it a permanent pursuit, expecting to become instructors or investigators. The especial aim of the course is to meet the requirements of this class of students. Their opportunity for study in schools under the guidance of teachers may end with our undergraduate course, or they may extend it to a graduate course in the Sheffield Scientific School or in other institutions abroad. In either case a like preparation is required for future work. The most indispensable part of this preparation is assumed to be a thorough knowledge of the fundamental principles of chemistry; a familiarity with chemical reaction attainable only by much *experience* in the laboratory and a careful training in analytical *chemistry.*

Besides those having the motives above defined, others may, and in fact do, enter this department of the School with advantage. There is a demand in the country for analytical chemists to fill positions connected with metallurgical or manufacturing establishments. For such as wish to fit themselves for these positions, the course is particularly favorable on account of the liberal amount of time it affords for laboratory practice in chemical analysis. It may also be recommended to those who expect to be actively connected with any manufacturing business which depends largely upon the employment of chemical processes.

The Course of Study.

Chemistry in its different branches is the principal study. The other subjects embraced in the course, which in respect to the amount of time devoted to them may be termed the minor studies, besides contributing something toward a general scientific education, are for the most part connected with the main object of the course. A knowledge of French and German, sufficient to render available the chemical literature of those languages, is indispensable to the advanced student. Mineralogy is so intimately connected with chemistry that it may properly be termed the chemistry of natural inorganic compounds, while a knowledge of the more important elements, or outlines of geology, may be considered of sufficient value in itself to repay the student for the moderate amount of time required for its acquisition.

The Freshman Year being designed to fit the student equally well for any of the courses which he may choose at the beginning of the Junior year, must necessarily include some studies which are not absolutely indispensable as a foundation to his future course. The Chemistry, Physics, German and in part the Mathematics of this year may be regarded as strictly preparatory to the chemical course.

Junior Year. During the greater part of this year instruction is given by means of text-books and recitations in chemical philosophy or "theoretical chemistry;" this may be considered as a continuation of the elementary chemistry studies during the Freshman year. Throughout the year the student spends four consecutive hours in the chemical laboratory five days of every week. On one day of the week exercises in Mineralogy take the place of Chemistry. *The laboratory* study is devoted to a systematic

course in analytical chemistry except during a part of the summer term in which analytical chemistry is replaced by experimental work in organic chemistry; this work consists of the preparation by synthetic methods of a series of organic compounds and is designed as a preparation for the systematic study of that branch of Chemistry which is carrried on during the Senior year. French and German are studied throughout the year.

Senior Year. During this year also about four hours daily are given to the study of analytical chemistry in the laboratory. At the end of the first term the student is familiar with the most important general analytical methods. The subject of his laboratory work during the second term is to a great extent optional. He may, if desirous, gain experience in the assaying of ores or analysis of some particular class of products with a view to its technical application; or he may devote his time to original research on some subject of scientific interest. Not less important, although requiring less time, is the study of organic chemistry. On account of the lack of a suitably organized laboratory for organic chemistry, experimental work, which under favorable circumstances would be highly desirable, is not carried on in connection with this study during the senior year. Lectures in zoology are attended during the first term and recitations in geology during the year. These exercises, together with three lessons weekly in French, fully occupy the time not required for chemical studies.

Method of Instruction.—In most of the studies of the course, instruction is given by means of text-books and recitations in the usual manner which requires no particular explanation. In regard to analytical chemistry, to which more time is allotted than to any other single branch of study in the course, it may be observed that it is intended to serve two purposes. It is to be used by the advanced student as a means of investigation in scientific or technical researches. The beginner, however, derives from its study advantages of another kind. The knowledge of the properties of chemical compounds, and familiarity with chemical reaction gained by experience in the laboratory, and the development of the reasoning faculties by the application of this knowledge in analytical processes, enables the student to generalize and classify chemical phenomena and it aids him to understand the more abstract theories of chemical philosophy. The method of instruction adopted is conformed to this view of the uses of the study. Text-books are used and recitations are required, but the more

ant part of both study and instruction is performed in the tory. In order to solve the problems which are thus pre-, the student, aided by books and instructors, must learn rinciples and their application.

Chemistry for Graduate Students.

School has been constantly increasing the facilities which 's to graduate students for the study of different branches mistry. The laboratories for analytical and physiological stry are open seven hours daily for their use.* They may with a course in quantitative analysis or with more ad- l work, according to their previous preparation. Each one es separately in the laboratory all assistance necessary to him to advance in proportion to his ability and diligence. tions in quantitative analysis accompany laboratory work the first term of the year. Graduates may also, if desirous, any of the recitations or exercises belonging to the above ed chemical course. After suitable preparation the under- of original investigations is encouraged. (The work of this arried on in our laboratories has afforded, it is believed, the valuable training possible for the student and has often d also in the production of contributions to science of con- ble value.)

The Chemical Laboratories of the School

e designated according to their special uses as follows:

A Laboratory for Elementary Chemistry, used exclusively struction of the Freshman class.

A Laboratory for Qualitative Analytical Chemistry.

A Laboratory for Quantitative Analytical Chemistry and s chemical investigations.

A Laboratory for Physiological Chemistry.

additional room in the basement of Sheffield Hall is fitted h furnaces and apparatus necessary for assaying of ores in y way, while the practice required in Determinative Miner- is carried on in a laboratory arranged especially for this se in the Peabody Museum.

ails concerning instruction in physiological chemistry, which forms an nt part of the course in *Biology*, may be found in the Annual Report for 78.

These laboratories are all satisfactorily supplied with apparatus and fixtures necessary for carrying on the work for which they are designed, but some of them are deficient in space. At the present time the laboratories for analytical and physiological Chemistry are occupied by forty-one students. Of these, thirty are undergraduates in the courses of Chemistry, Biology and Agriculture, eight are graduates and three are special students. They are working four hours daily under the supervision of four instructors. The combined capacity of the three rooms which they occupy, however, is quite insufficient to accommodate conveniently so large a number. To obviate these disadvantages which have been increasing every year, it is now determined, as stated above, to fit up the rooms which have been used hitherto by the Agricultural Experiment Station. These, it is expected, will be ready for occupancy at the beginning of the next Academic year.

Changes in the Corps of Professors.

It is with great regret that the Board are under the necessity of chronicling the loss of Professor Francis A. Walker, who has given up the position he held in this institution to accept the presidency of the Massachusetts Institute of Technology. Professor Walker has been connected with the school since 1871, though during the past two years his duties as Superintendent of the Census have not permitted him to give instruction. In the new and wide field of labor to which he has been called, the wishes of none will be more ardent for his success that those of his old associates in the Governing Board.

The place made vacant by Professor Walker's resignation has been filled by the choice of Professor Henry W. Farnam. Mr. Farnam was a graduate of the Academical Department of the class of 1874. After graduation he pursued a course of study in political economy and history at New Haven, and then went to Germany. He there studied for several years in various universities and finally took his degree in the faculty of law and political science at Strasburg. After his return in 1878 he acted as tutor in the Academical Department, and in 1880 was appointed University Professor of Political Economy.

Public Lectures.

The fifteenth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and the subjects are indicated in the following program:

I. Thursday, Feb. 10.—The Mississippi Jetties. Prof. Brewer.
II. Tuesday, " 15.—Life, from a Chemical Point of View. Dr. R. H. Chittenden.
III. Thursday, " 17.—Chocolate. Prof. Daniel C. Eaton.
IV. Tuesday, " 22.—The Laocoön. Prof. D. Cady Eaton.
V. Thursday, " 24.—Histriomastix, and the State Trials of William Prynne. Prof. Lounsbury.
VI. Tuesday, Mar. 1.—Prof. Trowbridge's Coil Boiler. Mr. F. R. Honey.
VII. Thursday, " 3.—The Bunsen Lamp, and Heating by Gas. Dr. H. P. Armsby.
VIII. Tuesday, " 8.—Our own Family of Languages. Prof. Whitney.
IX. Thursday, " 10.—The Structure and Germination of Seeds. Dr. E. H. Jenkins.
X. Tuesday, " 15.—Deep-Water Life off the U. S. Coast. Prof. Verrill.
XI. Thursday, " 17.—Public Parks. Prof. Baldwin.
XII. Tuesday, " 22.—Radiant Matter. Prof. Lyman.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1880–81. The order and subjects of the Lectures were as follows:

I. Monday, Feb. 21.—Strategy and Grand Tactics. Lieut. G. McC. Derby, U. S. Engineers.
II. Friday, " 25.—Logistics. Lieut. F. V. Abbot, U. S. Engineers.
III. Monday, " 28.—Small Arms and their influence on Tactics. Lieut. Eugene Griffin, U. S. Engineers.
IV. Friday, Mar. 4.—Artillery. Capt. J. B. Quinn, U. S. Engineers.
V. Monday, " 7.—Fortification. Capt. A. M. Miller, U. S. Engineers.
VI. Friday, " 11.—Sea Coast Defence. General H. L. Abbot, U. S. Engineers.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

During the past year, as in previous seasons, the most important additions to the Zoological collections have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the sea-bottom, off our coasts.

The headquarters of the Commission were at Wood's Holl, Mass., last season, and the work of dredging and trawling was carried on with great success from that point over an extensive region, both in the shallower waters and southward to the Gulf Stream slope, from 70 to 115 miles off shore, and to a depth of 600 fathoms.

This year, as last, the steamer "Fish Hawk," of 480 tons, built and fitted expressly for the scientific work of the Fish Commission, was employed in these explorations. The commander, Lieut. Z. L. Tanner, U. S. N., also made another trip, after the regular work of the season was over, to the deep-water off the mouth of Delaware Bay, with excellent results. The very extensive and valuable series of Invertebrata, obtained during these explorations, as well as numerous collections contributed to the Fish Commission by the bank fishermen of Gloucester, Mass., have all been sent to the Museum to be elaborated and reported upon, and eventually to be distributed. As fast as they are worked up, good series will be deposited in the Museum.

In the explorations, last summer, the curator was assisted by Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. J. H. Emerton, Professor L. A. Lee, and by Messrs. B. F. Koons, E. A. Andrews, and H. L. Bruner of the Sheffield Scientific School. Professor S. I. Smith also took part in the work during the season, devoting his time to the Crustacea.

Professor Smith has, as usual, taken charge of the Crustacea in the Museum. He has prepared for publication in the Bulletin of the Museum of Comparative Zoology accounts of the numerous new and strange forms of Crustacea, dredged in the deep water, off our coast, by Mr. A. Agassiz on the "Bache," in 1880.

The curator has published papers in the American Journal of Science, giving accounts of numerous new and interesting fishes, *mollusca*, echinoderms, etc., dredged in the deep water, off the coast. He has also printed in the Transactions of the Connecti-

cut Academy, vol. v, the second part of a monographic revision of the Cephalopods of our coast, and a lengthy report on the same subject in the Report of the U. S. Fish Commission. These papers are very fully illustrated.

Mr. J. H. Emerton, in addition to his regular duties, has made many drawings to illustrate several of the reports referred to above, and others in progress. He has also been engaged, for some time, upon a life-sized restoration of one of the gigantic Cephalopods of Newfoundland (*Architeuthis princeps*), for exhibition in the Museum. This is now nearly completed. When finished, it will be one of the most remarkable and instructive objects on exhibition.

Miss K. J. Bush has been employed, during the year, at the expense of the U. S. Fish Commission, to aid the curator in arranging and cataloguing the extensive collections that have accumulated, year after year, in connection with the explorations along our coast.

Miss Belle Voorhees has also been employed, in the same way, during a part of the year.

Aside from the collections referred to above, the most interesting and important addition made to the Museum, is a series of mounted birds from New Guinea, presented as a memorial of Charles A. Heald, of the class of 1881 (Y. C.), by his parents. This collection includes a series of four specimens of a recently discovered and rare, as well as beautiful, paradise-bird, the *Paradisea Raggiana*. Many other beautiful specimens are also contained in this collection, and nearly all were previously unrepresented in the Museum.

A small, but valuable, collection of rare bird skins from the high lands of Guatemala, has been presented by Mr. Guillesmo Nanne, through Mr. G. M. Totten.

Several large skins of mammals, birds and sharks have recently been mounted and put on exhibition. Among these is a very large white bear from Siberia, presented several years ago by Mr. Colin M. Ingersoll.

The following are other additions:

Richard Rathbun, specimens of Renilla, Gorgoniæ, and Antedon, from Brazil.

Professor T. A. Thacher, pelican from San Rafael, California. Collected by Albert E. Kent (Y. C. 1853).

Mrs. Peckham, *singular nest* of Oriole.

John P. Keep, Hamden, Cross-gray fox. Taken between Hamden and Bethany. (Purchased.)

H. Van Rensselaer (S. S. S.), internal parasites of fox, etc *Trichinæ* encysted in human muscles, from New York.

Wesleyan University, northern squids (*Ommastrephes*), from Newfoundland, collected by Mr. H. L. Osborn. (In exchange.)

E. B. Wilson (S. S. S. 1878), large specimens of *Balanoglossus* and of *Chætopterus pergamentaceus*, from Beaufort, N. C.

S. F. Clark (S. S. S. 1878), lancelets (*Amphioxus*), from Chesapeake Bay.

Professor W. K. Brooks, alcoholic specimens of *Lingula pyramidata*, from Rip Raps, Va.

Geo. W. Potter, North Haven, five living black snakes.

H. L. Bruner and E. A. Andrews (S. S. S.), living striped snakes, black snake, and turtles.

C. A. Houghton, W. Medway, Mass., tiger-cat, two species of agouti, duck, crocodile, and large lizard, mounted, from South America. (Presented.) Canada porcupine from Massachusetts and western fox-squirrel, mounted. (Purchased.)

Dr. J. Jullien, Paris, Bryozoa and shells. (In exchange.)

A. P. Goodwin, shells from Australia, etc. (In exchange.)

B. F. Koons and E. A. Andrews (S. S. S.), lot of *Artemia fertilis*, West Haven.

N. Vickary, Lynn, Mass., birds, mounted, from Massachusetts (Purchased.)

Professor B. Silliman, forty-nine bird-skins, from California, collected by E. F. Lorquin.

A. E. Verrill, birds and mammals, mounted, from Massachusetts. (Deposited.) Shells, insects, spiders, myriapods, from Wythe Co., Va.

National Museum. A very large shell (*Fusus Aruanus*); a fresh specimen of the recently discovered "tile-fish" (*Lopholatilus*); mounted by Mr. Vickary.

Museum of Havre, France, through M. Auguste Briand. Specimens of cuttle-fishes (*Sepia officinalis* and *Loligo vulgaris*). (In exchange.)

T. S. Gold, West Cornwall. Snake with two heads; fœtal lamb, etc.

Thos. Trowbridge, New Haven. Collection of shells from St. Christopher, W. I. Three large crabs, from West Indies.

Howard Hitchcock. Young turtle (*Ozotheca odorata*).

G. F. Allen, New Haven. Collection of local land and fresh-water shells.

A. E. Van Name. Menobranchus from near Independence, Wis.

Horace Bowman, New Haven. Rare fish and *Squilla empusa*, Long Island Sound.

Wm. Fuller, New Haven. Specimen of *Squilla*.

Professor B. G. Wilder, Ithaca, N. Y. By exchange. Living mud fish (*Amia calva*) and Menobranchi from Cayuga Lake. In alcohol, *Menobranchus*, young of *Lepidosteus* and *Amia; Amphioxus* from the Mediterranean.

Captain Fred. Hotchkiss. Porcupine-fish (*Tetradon*), from West Indies.

Captain Joseph A. McLure, through Thos. Trowbridge, Jr. Lizard from Dominica; pair of Hercules beetles.

F. S. Smith (Y. C. 1874), New Haven. Internal parasites of Canada Porcupine, Lewis Co., N. Y.

V. N. Edwards, Wood's Holl, Mass. Parasites of eels.

Gen. G. K. Warren, U. S. A. Mud containing shells, dredged up in New Bedford Harbor. Among the shells is *Pholas costata*.

Guillesmo Nanne, Costa Rica, through G. M. Totten. Collection of bird skins from Guatemala.

ANNIVERSARY.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 28, 1881. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

BACHELORS OF PHILOSOPHY. (43).

CHARLES FRANCIS ADAMS (Dynamic Engineering), *Jessups, Md.* On the Hydraulics of a Steam Launch, with Design for propelling the same.

ETHAN ALLEN ANDREWS (Natural History), *Tarrytown, N. Y.* On the Anatomy of the Spider-Crab (*Libinia emarginata*).

EDWARD BAILEY, JR. (Dynamic Engineering), *Harrisburg. Pa.* Design for a Direct-acting Steam Crane.

FRANK LEWIS BIGELOW (Dynamic Engineering), *New Haven.* On the Colt Disc Engine.

GEORGE FREDERICK BOSWORTH (Civil Engineering), *Milford.* On English vs. American *Bridge Building.*

*LESTER PAIGE BRECKENRIDGE (Dynamic Engineering), *Westfield, Mass.* On the Methods of Measuring Motive Power.

CHARLES SHELDON BURNHAM (Dynamic Engineering), *Woodbridge.* Original Design for an Expansion Gear.

*HOWARD FIELD CHAPPELL (Chemistry), *Chicago, Ill.* On the Reaction of Phosphoric Acid with Sodium Chloride.

CHARLES MANVILLE DOWNS (Biology), *New Haven.* On the Histology of the Alimentary Canal of the Cat.

*JOHN SLADE ELY (Biology), *New York City.* On the Exoskeleton of *Tulorchestia longicornis.*

GEORGE SHERMAN FOLSOM (Select), *Northford.* On International Copyright.

SEYMOUR FRANCIS FRASICK (Biology), *Hartford.* On the Exoskeleton and Nervous System of *Crangon vulgaris.*

ALBERT MOSES GERSTLE (Select), *Youngstown, O.* On the Anti-Jewish Agitation in Germany.

*HENRY HOLBROOK GLADDING (Civil Engineering), *New Haven.* On the Superstructure of the East River Bridge.

*WILLIAM LOOMIS GRISWOLD (Biology), *Banksville.* On the Influence of Acids and Alkalies on the Diastatic Action of Saliva.

FREDERIC JONATHAN HILLER (Chemistry), *Cohoes, N. Y.* On the Coloring Matter of Young Fustic.

SAMUEL HIGGINS (Dynamic Engineering), *Buffalo, N. Y.* On the History of the Locomotive.

BLAIN JAMISON (Select), *New Orleans, La.* On the Protective System in the United States.

JEME TIEN YOW (Civil Engineering), *Canton, China.* Review of a Large Wharf Crane.

BENJAMIN FRANKLIN KOONS, B.A., Oberlin College (Natural History), *Sulphur Springs, O.* On the Structure of a Phyllopod Crustacean (*Eubranchipus vernalis*).

EDMUND PARKER LORD (Dynamic Engineering), *Saxonville, Mass.* On the Steam Boiler, and Boiler Explosions.

RICHARD BEEKER LYON (Civil Engineering), *New Haven.* Discussion of the Roof of the Insurance Building at New Haven.

SILAS METZGER (Select). *New Haven.* On the Life-Saving Service of the United States.

EDWIN KIRTLAND MORSE (Civil Engineering), *Poland, O.* Review of a Bridge at Struthers, Ohio.

MARCUS DATY MUNN (Chemistry,) *Southington.* On the Determination of Manganese in Silicates.

MARVIN OLCOTT (Dynamic Engineering), *Corning, N. Y.* On the Steam Engine Governor.

OWYANG KENG (Dynamic Engineering), *Canton, China.* On the Steam Indicator.

FRANCIS STUYVESANT PEABODY (Select), *Chicago, Ill.* On the Taxation of Mortgages.

OLIVER PHELPS (Select), *Canandaigua, N. Y.* On the Relation of Railroads to the Prosperity of the Country.

*ADDISON ALEXANDER RIGHTER (Dynamic Engineering), *Newark, N. J.* Design for a Calorimeter for Determining the Amount of Moisture in Steam.

WIS SARGENT (Dynamic Engineering), *New Haven.* Report of a Series l Tests upon a Wheelock Engine of One Hundred and Fifty Horse

)B SCHILLER (Chemistry), *New Haven.* On Volumetric Methods for ination of Iron.

)SEPH SHANLEY (Select), *New Haven.* On the Navigation Laws.

)USTUS SMITH (Select), *New Haven.* On Free Ships.

VARD TRUMBULL (Biology), *Talcahuano, Chili.* On the Histology of nd Teeth.

NDSAY TRUMBULL (Biology), *Talcahuano, Chili.* On the Influence of)n the Products of Digestion.

AN RENSSELAER (Biology), *Albany, N. Y.* On the Exoskeleton of *)bius Americanus*, a new species of *Aranеina.*

RLES WARNER (Civil Engineering), *West Suffield.* On the Water ly of Westfield, Mass.

LLIAM WATSON (Dynamic Engineering), *Ashtabula, O.* On the Per- Motion, with a Discussion of Gamgee's "Zero-Motor."

MEEKER WOOD (Dynamic Engineering), *Morristown, N. J.* On the ical Theory of Heat.

URNHAM WOODFORD (Select), *West Winsted.* On the Proposed Amer- ter-Oceanic Canal.

GHT (Biology), *West Roxbury, Mass.* On the Histology of the Ali- y Canal of the Shad (*Alosa sapidissima*).

NTON WRIGHT (Civil Engineering), *Cromwell.* On Compressed Air as to Engineering Constructions.

PRIZES.

lowing prizes were awarded during the year:

CLASS OF 1881.

e in Civil Engineering, the prize divided between GEORGE FREDERICK TH, of *Milford*, and HENRY HOLBROOK GLADDING, *New Haven.*

Prize for excellence in Zoological and Biological studies, awarded to ALLEN ANDREWS, of *Tarrytown, N. Y.*

CLASS OF 1882.

e in the Mathematics of Junior Year, the prize awarded to FRANK JUD- MBERT, *New Haven.*

CLASS OF 1883.

e in all the Studies of Freshman Year, the prize awarded to EDWARD RD DENCH, *Bridgeport*, with honorable mention of JOHN BARTHOLO- *uilford*, and FREDERIC ELIJAH BEACH, *New Haven.*

e in Mathematics, the prize awarded to JOHN ALPHEUS ALLEN, *New* with honorable mention of JOHN BARTHOLOMEW, Guilford, FREDERIC BEACH, *New Haven*, and EDWARD BRADFORD DENCH, Bridgeport.

For excellence in German, the prize awarded to EDWARD BRADFORD DENC *Bridgeport.*

For excellence in Physics, the prize divided between JOHN ALPHEUS ALLEN, N *Haven*, and EDWARD BRADFORD DENCH, *Bridgeport.*

For excellence in Chemistry, the prize awarded to JOHN ALPHEUS ALLEN. N *Haven*, with honorable mention of JOHN BARTHOLOMEW, *Guilford*, a EDWARD BRADFORD DENCH, *Bridgeport.*

For excellence in Mechanical Drawing, the prize awarded to CHARLES SUMN BROWN, *East Hampton*, with honorable mention of JOHN BARTHOLOMI *Guilford*, FREDERIC ELIJAH BEACH, *New Haven*, and JOSEPH ALLEN SKINN *Holyoke, Mass.*

For excellence in English Composition, first prizes awarded to GEORGE ANDR BARROWS, *Philadelphia, Pa.*, EBENEZER HUBBARD SKINNER, *Escambia, F* and ROBERT HAWTHORNE WYLIE, *Chester, S. C.*; second prizes awarded THEODORE DAVENPORT BACON, *Norwich*, EDWARD BRADFORD DENCH, *Bri port*, WILLIAM HARPER, *Shippensburgh, Pa.*, JOHN ELMER LOCKWOOD, *St ford*, JOHN EDMUND NEWELL, *Chicago. Ill.*, GEORGE SHIPMAN PAYSON. *cago. Ill.*, and EDWARD IRVING STONE, *Bethlehem.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1881-2.

CALENDAR.

1881.		
15 Sept.	Thursday,	First Term begins.
22 Dec.	Thursday,	First Term ends.
1882.		**Winter Vacation of three**
12 Jan.	Thursday,	Second Term begins.
5 April,	Wednesday,	Spring Recess begins.
12 April,	Wednesday,	Spring Recess ends.
27 June,	Tuesday,	Meeting of Appointing Board.
27 June,	Tuesday.	Anniversary.
28 June,	Wednesday,	Commencement.
29, 30 June, 1 July,	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of eleven
12, 13 Sept.	Tues., Wedn.,	Examination for Admission.
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the *bered from 1 to 21* are in Sheffield Hall; from 26 to 58 in North Sheff

CORPORATION.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY HOBART B. BIGELOW, NEW HAVEN.
HIS HONOR WILLIAM H. BULKELEY, HARTFORD.
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REV. HIRAM P. ARMS, D.D., NORWICH TOWN.
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MASON YOUNG, M.A., NEW YORK CITY.

SECRETARY.

FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

)AH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

E J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

.M A. NORTON,
l Engineering. (34 N. S. H.) 72 Prospect st.

:R S. LYMAN,
sics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

.M D. WHITNEY,
uistics and French. (205 D.) 246 Church st.

E J. BRUSH,
eralogy. (3 S. H.) 14 Trumbull st.

L W. JOHNSON,
retical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

.M H. BREWER,
icultural (NORTON *Professor*). (4 S. H.) 246 Orange st.

. CLARK.
hematics. (40 N. S. H.) 29 Eld st.

. C. EATON,
ny. (41 N. S. H.) 70 Sachem st.

S R. LOUNSBURY,
lish. 22 Lincoln st.

D. ALLEN,
lytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

N E. VERRILL,
'ogy and Geology. (15 P. M.) 148 College st.

I. SMITH,
parative Anatomy. (14 P. M.) 148 College st.

M G. MIXTER,
nistry. (8 S. H.) 8 Trumbull st.

DUBOIS,
amical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

W. FARNAM,
tical Economy and History. 43 Hillhouse av.

LECTURERS, INSTRUCTORS AND ASSISTANTS.

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 27 Eld st.

MARK BAILEY,
Elocution. (150 F.) 200 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

HERBERT MILLER,
French. 57 Trumbull st.

THOMAS W. MATHER,
Kinematics and Machine Design. (45 N. S. H.) 19 Warren pl.

ALLEN B. HOWE,
Analytical Chemistry. 138 College st.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (13 S. H.) 95 Humphrey st.

CHARLES HILDEBRAND,
Mathematics. 34 Chesnut st.

SAMUEL L. PENFIELD,
Mineralogy. (2 P. M.) 14 S. H.

MARCUS D. MUNN,
Analytical Chemistry. 55 N. S. H.

GRADUATE STUDENTS.

ı Andrews, PH.B.	*Tarrytown, N. Y.*	N. S. H.
iley, PH.B.	*Harrisburg, Pa.*	489 Chapel st.
rleton, A.B. College.	*Amballa, India.*	215 York st.
Ely, PH.B.	*New York City,*	57 N. S. H.
lebrand, D.E.	*New Haven,*	34 Chestnut st.
ards Hooker, B.A.	*New Haven,*	62 Prospect st.
lerick Klein, D.E.	*New Haven,*	14 Whalley av.
ldron Lambert, B.A.	*New York City,*	90 High st.
ınian, urkey College.	*Aintab, Turkey,*	72 High st.
nund Linde, B.A.	*New Haven,*	133 Congress av.
on, M.A. on and Jefferson College, Pa.	*Washington, Pa.*	49 Grove st.
y Munn, PH.B.	*Southington,*	55 N. S. H.
less Nye, B.A. College.	*Marietta, O.*	91 W.
ius Penfield, B.A.	*Catskill, N. Y.*	14 S. H.
les Warner, PH.B.	*West Suffield,*	305 Orange st.
e Waters, B.S. College, Ky.	*Garrettsville, O.*	21 Home pl.
liam Watson, PH.B.	*Ashtabula, O.*	498 Chapel st.
nham Woodford, PH.B.	*West Winsted,*	16 S. H.
olsey, B.A.	*New Haven,*	250 Church st.

GRADUATES, 19.

SENIOR CLASS.

Horace Ellsworth Andrews,	*Cleveland, O.*	43 College st.
Alfred Warner Armstrong,	*Cleveland, O.*	43 College st.
Charles Noyes Batcheller,	*Wallingford, Vt.*	114 High st.
Henry Jonathan Biddle,	*Philadelphia, Pa.*	36 Elm st.
Francis Hayes Blake,	*New Haven,*	119 W.
Nathan Gross Bozeman,	*New York City,*	31 Temple st.
Frederick Casper,	*West Meriden,*	215 York st.
William Anson Chamberlin,	*New Haven,*	30 Trumbull st.
William Henry Crocker,	*San Francisco, Cal.*	36 Elm st.
James John Drummond,	*Winfield, Ill.*	114 High st.
Richard Lawrence Everit,	*New Haven,*	281 Whitney ave.
Herbert Waldron Faulkner,	*Stamford,*	23 Prospect st.
William Alanson Hall,	*Morris,*	106 Wooster st.
Alexander Bryan Johnson,	*Utica, N. Y.*	62 W.
Frederick William La Forge,	*Waterbury,*	167 Temple st.
Frank Judson Lambert,	*New Haven,*	12 Eld st.
Norman Smith Latham,	*North Manchester,*	120 Dwight st.
Cassius Samuel Lyman,	*Holyoke, Mass.*	67 Mansfield st.
Sheldon Elton Minor,	*Thomaston,*	167 Temple st.
Edward E. Paramore,	*St. Louis, Mo.*	36 Elm st.
Louis Valentine Pirsson,	*New York City,*	121 Park st.
Harry Smith Pope,	*Jersey City, N. J.*	61 W.
Robert Browning Rood,	*Great Barrington, Mass.*	167 Temple st.
Charles Edward Stockder, Jr.	*West Meriden,*	167 Temple st.
Fred Moore Strong,	*Boston, Mass.*	36 Elm st.
Henry Taber,	*New York City,*	33 Prospect st.
Arthur Graham Thompson,	*Milford,*	43 College st.
Edwin Thorne,	*New York City,*	62 W.
Thomas Pearsall Thorne,	*Millbrook, N. Y.*	71 W.
Walter Joy Vought,	*Buffalo, N. Y.*	85 W.
Edward Loder Whittemore,	*Rye, N. Y.*	76 W.
Alfred Buckingham Willcox,	*Chicago, Ill.*	76 W.
Chauncey Pratt Williams, Jr.	*Albany, N. Y.*	36 Elm st.
S. Lawrence Williams,	*Chicago, Ill.*	36 Elm st.

SENIORS, 34.

JUNIOR CLASS.

ıin Abbott,	*New Haven,*	257 Church st.
ıeus Allen,	*New Haven,*	189 Temple st.
Safford Barrows,	*Hartford,*	163 Temple st.
ıdrew Barrows,	*Philadelphia, Pa.*	43 College st.
holomew,	*Guilford.*	17 Wooster pl.
tobinson Bartlett,	*Freeport, Ill.*	36 Elm st.
Elijah Beach,	*New Haven,*	33 Lyon st.
ıitney Berryman,	*New York City,*	464 Chapel st.
ıon Boothe,	*Birmingham,*	143 York st.
llan Bowles,	*Springfield, Mass.*	167 Temple st.
Truman Bradley,	*New Haven,*	142 Orange st.
ırker Breese,	*Meriden,*	458 Chapel st.
ımner Brown,	*East Hampton,*	114 High st.
ilo Carpenter,	*Madison, Wisc.*	36 Elm st.
ıymond Carpenter,	*Afton, N. Y.*	60 w.
yron Chase,	*Chicago, Ill.*	184 York st.
ley Coates,	*Kansas City, Mo.*	66 w.
son Covell,	*Stamford,*	31 Temple st.
rlington,	*West Chester, Pa.*	136 College st.
radford Dench,	*Bridgeport,*	67 Mansfield st.
lsey Devereux,	*Cleveland, O.*	43 College st.
den DuBois,	*New Haven,*	328 Howard av.
eers Eastwick, Jr.	*New York City.*	36 Elm st.
ıuthworth Frazer,	*Holyoke, Mass.*	77 w.
ıckwood Gold,	*West Cornwall,*	49 Grove st.
ewart Hall,	*Warren, O.*	36 Elm st.
ınce Harper,	*Denver, Col.*	41 Trumbull st.
arper,	*Shippensburg, Pa.*	136 College st.
bard.	*Westfield, Mass.*	114 High st.
r Johnson.	*Rome, Ga.*	41 High st.
ır Lockwood,	*Stamford,*	146 Dixwell av.
lison Lockwood,	*Stamford,*	146 Dixwell av.
ɔan,	*Middlefield,*	107 w.
ın,	*Middlefield,*	107 w.
y Mann,	*Utica, N. Y.*	43 College st.
ant Mitchell, Jr.	*Edgewood,*	134 College st.
ınd Newell,	*Chicago, Ill.*	73 w.
tis Nutt, Jr.	*Boston, Mass.*	36 Elm st.
ipman Payson,	*Chicago, Ill.*	109 Wall st.
ells Penfield,	*Chicago, Ill.*	109 Wall st.
vard Pope, Jr.	*Jersey City, N. J.*	61 w.
doch Pratt.	*Elmira, N. Y.*	36 Elm st.
man Randall.	*Birmingham,*	72 High st.

Albert William Robert,	*New York City*,	36 Elm st
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	203 York st.
Frederick Baylies Samson,	*Richmond, Ind.*	458 Chapel st.
Charles Lansing Sayre,	*Utica, N. Y.*	43 College st.
Horace Lee Simpson,	*Pensacola, Fla.*	114 High st.
Ebenezer Hubbard Skinner,	*Escambia, Fla.*	114 High st.
Joseph Allen Skinner,	*Holyoke, Mass.*	106 Wall st.
Edward Irving Stone,	*Bethlehem*,	72 High st.
John Edwards Stryker,	*Catskill, N. Y.*	77 W.
Alonzo Felton Wood, Jr.	*West Haven*,	77 George st.
Alexander Wurts,	*New Haven*,	65 Whitney av.
Robert Hawthorne Wylie,	*Chester, S. C.*	136 College st.

JUNIORS, 55.

FRESHMAN CLASS.

Alfonso,	*New York City,*	36 Elm st.
Harvey Allcutt,	*Kansas City, Mo.*	66 w.
Law Allen,	*New Haven,*	38 Eld st.
Mayes Anderson,	*Mayfield, Ky.*	347 York st.
len Armour,	*Chicago, Ill.*	200 York st.
udley Barry,	*Constantine, Mich.*	36 Elm st.
llen Benedict,	*Bethel,*	494 Chapel st.
e Vincent Benét,	*Washington, D. C.*	74 High st.
Blake,	*New Haven,*	149 Temple st.
Francis Bosworth,	*Milford,*	285 York st.
Russell Britton,	*Cleveland, O.*	128 High st.
r Rea Burr,	*Portland, Me.*	420 Chapel st.
ark Campbell,	*New Haven,*	16 York sq.
DeWitt Carrington,	*New Haven,*	527 Chapel st.
ustin Chambers,	*New York City,*	94 Grove st.
Brainard Coit,	*New London,*	44 Elm st.
awrence Colton,	*Canton,*	347 York st.
ward Cooper,	*Ansonia.*	25 Prospect st.
oseph Cornell,	*New York City,*	489 Chapel st.
Vyckoff Cummins,	*Vienna, N. J.*	347 York st.
owling Dann,	*New Haven,*	280 Ferry st.
1 Wales Dodge,	*Middlebury, Vt.*	221 Elm st.
Bailey Downing,	*Wilmington, Del.*	44 Elm st.
Percival Farquhar,	*York, Pa.*	27 Prospect st.
rthur Fawcett,	*Cleveland, O.*	128 High st.
ixby Ferguson,	*New Haven,*	539 Howard av.
rt Galbraith,	*Erie, Pa.*	489 Chapel st.
dsey Grout,	*Detroit, Mich.*	161 Temple st.
Augustus Guinnip,	*Elmira, N. Y.*	494 Chapel st.
Hague,	*Tidioute, Pa.*	31 Trumbull st.
nsley Harrison,	*New Haven,*	139 Greene st.
l Hatcher,	*Jefferson, Ia.*	12 Elm st.
Brown Hawley,	*Yonkers, N. Y.*	139 Chapel st.
. Hepburn,	*Jersey Shore, Pa.*	74 High st.
Jusser Herr,	*Denver, Col.*	289 York st.
Henry Hopper,	*Cleveland, O.*	128 High st.
enry Jennings.	*Redding,*	215 York st.
Crossley Johnson,	*New Haven,*	31 Vernon st.
eith, Jr.	*Chicago, Ill.*	200 York st.
udson Kelsey,	*Killingworth,*	29 High st.
Hall Keyes,	*Stony Creek,*	25 Prospect st.
Merriam Kirkham,	*Springfield, Mass.*	94 Grove st.
ucas,	*Philadelphia, Pa.*	161 York st.
Heath Lyon, Jr.	*Brooklyn, N. Y.*	169 Temple st.
linor *Maghee,*	*Orange, N. J.*	33 Prospect st.

Frederick Lincoln Markham,	*Tyler City,*	25
Luther James Martin,	*New Haven,*	
Seyton Howard Martin,	*Clifton, N. Y.*	
George Smith Hunt McDowell,	*Portland, Me.*	4
Frank Harbottle McIntosh,	*Peterboro, N. H.*	13
Henry Moorhead Montgomery,	*Portland, Oregon,*	
George Edgar Moulthrop,	*New Haven,*	253 No
William Wallace Nichols,	*Manitou Springs, Col.*	
Albert Anderson Noye,	*Buffalo, N. Y.*	4
Herbert Lincoln Noyes,	*New Haven,*	
Edson May Peck,	*Bristol,*	
Willis LaFayette Perkins,	*Portland, Me.*	4
John Thompson Perry,	*Brunswick, Me.*	
Elbridge Worthington Pierce,	*Brookfield Centre,*	1
Louis Morgan Porter,	*Philadelphia, Pa.*	
Joseph Powell, Jr.	*Towanda, Pa.*	16
George Simon Roberts,	*New York City,*	
Walter Allen Sadd,	*South Windsor,*	17
William Godfrey Sage,	*Chicago, Ill.*	17
Russell Sargent,	*New Haven,*	
William Tuttle Shepard,	*Bristol,*	
Charles Allen Stone,	*Springfield, Mass.*	5
Chester Thorne,	*Millbrook, N. Y.*	65
Thomas Rutherford Trowbridge, 3d,	*New Haven,*	4
James Henry Warner,	*Steubenville, O.*	
Elmore Abram Willets,	*Belmont, N. Y.*	
Edward Simpson Wilson,	*New York City,*	13
Andrew Lincoln Winton,	*Bridgeport,*	
James Prior Wood,	*West Haven,*	7
William Mason Wright,	*Newark, N. J.*	3

FRES

SPECIAL STUDENTS NOT CANDIDATES FOR A DE

John Edward Calhoun,	*Cornwall,*	
Edward Seymour Hotchkiss,	*Bridgeport,*	67 1
Frederick Knowlton Mixer,	*Buffalo, N. Y.*	1
Warren A. Spalding,	*New Haven,*	8
Lyman Child Wooster,	*Whitewater, Wisc.*	23

SPECIAL STU

SUMMARY.

Graduates,	19
Seniors,	34
Juniors,	55
Freshmen,	75
Special,	5
Total,	188

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction nd researches in the mathematical, physical, and natural sciences, ith reference to the promotion and diffusion of science, and also) the preparation of young men for such pursuits as require pecial proficiency in these departments of learning. It is one of ie Departments of Yale College, like the law, medical, theologi-l, and art schools, having its separate funds, buildings, teachers, nd regulations, but governed by the Corporation of Yale Col-ge, which appoints the professors and confers the degrees. It , in part, analogous to the academic department, or classical col-ge, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other Colleges, and other persons ualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical nd scientific, in less part linguistic and literary, for higher scien-ific studies, or for various other occupations to which such raining is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient uilding and a considerable endowment were given by Joseph E. heffield, Esq., of New Haven, whose name at the repeated equest of the Corporation of Yale College, was afterward ttached to the foundation. Mr. Sheffield has since frequently nd munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national rant for the promotion of scientific education (under the con-ressional enactment of July, 1862) was given to this department f Yale College. Since that time, and especially since the autumn f 1869, *numerous liberal gifts* have been received from the citi-

zens of New Haven, and from other gentlemen in Connecticu New York, and St. Louis, for the endowment of the School, ar the increase of its collections.

The action of the State led to the designation by law of a Sta Board of Visitors, consisting of the Governor, Lieutenant-Go ernor, three senior Senators, and the Secretary of the State Boa of Education; and this Board, with the Secretary of the Scie tific School, is also the Board for the appointment of students hold the State scholarships.

At the request of the Governing Board, the Corporation Yale College has also appointed a Board of Councillors for th School, consisting of a number of gentlemen who have taken deep interest in its welfare.

The Governing Board consists of the President of Yale Co lege and the Professors who are permanently attached to th School. There are several other instructors associated with the a part of whom are connected with other departments of th College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in th Scientific School is mainly carried on are called Sheffield Hall ar North Sheffield Hall; but instruction in Mineralogy, Geolog and Biology, including Zoölogy and Comparative Anatomy, now given entirely in the Peabody Museum. These halls co tain a large number of recitation and lecture rooms, a hall f public assemblies and lectures, chemical and metallurgical labor tories, a photographical room, an astronomical observator museums, a library and reading room, besides studies for some the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belon ing to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photograph and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular *needs and capacities of* each student, and may be combined

with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, and the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter *time, to* graduate students who do not desire to become candi*dates* for a degree.

Students who have taken the degree of Bachelor of Philosophy, ay obtain the degree of CIVIL or of DYNAMIC ENGINEER at the id of two academical years, by pursuing the following higher ›urse of study and professional training.

The course of study for the degree of CIVIL ENGINEER will ›mprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and ractice, the candidate will be required to furnish a comprehensive eport of the results of an examination into the existing condition f some special line of constructive art; or to present proper evi- ence that he has had actual charge in the field, for several ionths, of construction or surveying parties, or held some esponsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected ork of construction, based upon exact data obtained from care- ul surveys made by the candidate, and comprising all the requi- ite calculations, and the necessary detailed drawings, and accom- anied by full specifications of the work to be done, and the equirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will ›mprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ uch a portion of their time as may be deemed advisable or neces- ary in the examination of engineering works and manufacturing stablishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to profes- sional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling, and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, or the First and Second Latin Books of the Ahn-Henn Latin Series (E. Steiger & Co., New York) are named as indicating the nature and extent of this requirement, and an acquaintance with one of these works will be required unless some satisfactory substitute is offered. In the last-named course one-third of each exercise may, if desired, be omitted.) (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar quantity of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

Algebra—Fundamental Operations, Fractions, Equations of the First Degree, with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

For preparation in Algebra and Geometry the recently published text-books of Professor Newcomb on these subjects (Henry Holt & Co., New York, 1881), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on the Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trignometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant *applications of them* to all forms of calculation occurring in

ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 29, 30, July 1, and on Tuesday and Wednesday, September 12, 13, 1882. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1882, examinations (for the Freshman Class only), will also be held in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 29, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Plane Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Elementary, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Qualitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of Line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—Continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structure; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-Heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids: Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels: Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; *Complete* working drawings for a high speed Steam Engine. Shop Visits and *Reports. Metallurgy.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry* — Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice* — Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Anatomy and Physiology*—Martin's Human Body. *Botany*—Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry* — Lectures and Recitations. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology* — Dana's. *Rural Economy* — History of Agriculture and Sketches of Husbandry in Foreign Countries; Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Anatomy and Physiology*—Martin's Human Body. *Mineralogy* — continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Text-book; Excursions. *French.*

SECOND TERM — *Geology* — Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice: Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Physiology*—Martin's Human Body. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiological Chemistry*—Sanderson's Hand-book; Recitations and Laboratory Work. *Mineralogy*—continued. *Botany*—Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Green's Short History of the English People. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Green's History, continued; History of the United States. *German. French.*

SENIOR YEAR:

1ST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and sions. *Linguistics*—Whitney's Life and Growth of Language. *English*—pere. *Constitutional Law of the United States. French.*

OND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy* itations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, ıter authors. *French.*

cercises in English Composition are required during the entire se from all the students. The preparation of graduating the- s among the duties of Senior Year.

ctures on Military Science and Tactics are annually given General Abbot, and other officers of the Engineer Corps of United States Army.

RAWING.—The course in drawing extends through the three s. During the first term of Freshman year, the students tice free-hand drawing at the Art School building, under the ction of Professor Niemeyer, of the Yale School of the Fine s. After the completion of the course in free-hand drawing, ruction is given by Mr. F. R. Honey, during the second term he elementary principles of instrumental drawing, embracing nentary projection drawing, Isometric drawing, and Descrip- Geometry as far as Warped Surfaces. This course is obliga- upon all.

uring the Junior and Senior years, instruction in drawing is gatory only on the students in Civil and Mechanical Engin- ng. In the former year the system of instruction embraces les and shadows, tinting, perspective, and warped surfaces. this method all the problems in Descriptive Geometry are ired to be worked out on the drawing-board instead of the k-board. The course extends through the entire year, and is er the direction of Mr. Honey.

n Senior year, students are required to apply the principles of wing already obtained to works of construction, under the eral supervision of the Professors of Civil and of Dynamic gineering.

VII.

METHODS OF INSTRUCTION.

he instruction of this institution is given chiefly in small class ms, in connection with recitations and by familiar lectures, strated *by the apparatus* at the command of the various

teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and in disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they *have* learned, and the collections they have made are considered to be of minor importance.

In Zoology excursions are made during the Summer term of unior and Fall term of Senior year, in company with the nstructors, for the purpose of observing the habits and making ollections of marine, fresh-water, and terrestrial animals of all lasses. Each student is required to prepare and present for xamination a collection containing a specified number of species, nd illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, *and his judgment* is trained in choosing relative

proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 28–41.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 36.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 14, 1882. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. *The appointing* Board for the current year, consist-

ing of the Board of Visitors of the State and the Secretary o the School, will meet on June 27th, 1882, and at or about th same time in the year 1883, due notice of which will be given b publication in every county of the State. All applications shoul be made previous to that time. Blank forms for application wi be sent, when requested, by Professor GEORGE J. BRUSH, Secr tary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of t Commencement week in Yale College, when selections from t graduation theses are publicly read. The degrees are public conferred by the President and Fellows of Yale College on Co mencement Day.

APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1881, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JUNE, 1881.

1. Ascertain whether the fraction $\frac{2458}{61937}$ is in its lowest terms or not, and explain the process you employ.

2. (*a*) Divide $\frac{7}{257}$ by $\frac{3}{241}$ and explain the process.

(*b*) Can the quotient be exactly expressed by a terminating decimal? Give a reason for your answer.

3. Divide 0.00309824 by 0.0376, and explain the position of the decimal point in the quotient.

4. If a body revolves uniformly in the circumference of a circle at the rate of 12° 15′ 25″ per minute, how long is it in performing a complete revolution?

5. If 6 men, working uniformly at a certain rate, do a certain piece of work in 17 days of 9 hours each, how many days of $8\frac{1}{2}$ hours each will 24 men, working uniformly at the same rate, require to do 20 such pieces?

6. $5674.83 is 105 per cent. of what sum?

7. Extract the square root of 2.26 to three places of decimals. Show how you can derive from the square root of this number that of 0.0226.

8. Find the weight in grams of a rectangular bar of gold 1 decimeter long, $2\frac{1}{2}$ centimeters wide, and 2 centimeters thick, assuming the bar to be 19 times as heavy as its own volume of pure water at its maximum density.

ARITHMETIC.

SEPTEMBER, 1881.

1. Find the least common multiple of 1011, 1685 and 2359.

2. A man bought 16 horses and 19 cows for $1855. He paid upon the average $\frac{7}{15}$ as much for a cow as he did for a horse. What was the average price he paid per head for the horses?

3. Divide 0.006102 by 2.034 and explain the position of the *decimal* point.

4. Reduce 18,216 ft. to miles and decimals of a mile.
5. A company whose capital is $275,000 has $15,125 from its nings to divide. What per cent. dividend can it declare upon e basis of this sum?
6. If a block of granite 8 ft. long, 2 ft. wide and 1 ft. 6 in. thick eigh 920 lbs. how much will a block of the same kind of granite eigh which is 12 ft. long, 3 ft. wide, and 2 ft. thick.
7. Extract the cube root of 1.025 to three places of decimals.
8. (*a*) In 2.15 cubic meters how many cubic millimeters? Re-ce approximately (*b*) 600 kilometers to miles, and (*c*) 50 grams grains.

GEOMETRY.

JUNE, 1881.

OTE 1.—Candidates for examination on the whole of this subject should take whole of this paper. Candidates for the first year's partial examination should e the first part; those for the second year's partial examination, the second part.
OTE 2.—State what text-book you have studied on the subject, and to what ent.

I.—PLANE GEOMETRY.

1. Of two oblique lines drawn from the same point to the same raight line, that is the greater which cuts off upon the line the eater distance from the foot of the perpendicular. Corollaries.
2. In any triangle the product of two sides is equal to the oduct of the diameter of the circumscribed circle by the per-ndicular let fall upon the third side from the vertex of the pposite angle.
3. Two sides of a triangle and the angle opposite to one of iem being given to construct the triangle.
4. The area of a circle is equal to half the product of its cir-umference by its radius.
5. Calculate the area of a circle whose radius is 10 ft.

II.—SOLID AND SPHERICAL GEOMETRY.

6. The sum of any two face angles of a triedral angle is greater han the third.
7. If the base of a cone is a circle, every section of the cone nade by a *plane parallel to* the base is a circle.

8. Calculate the area in square feet of a spherical triangle on a sphere whose radius is 10 ft., the angles of the triangle being 70°, 80°, and 120°.

9. Calculate the area of a zone on the sphere whose radius is 10 ft., the altitude of the zone being 3 ft.

10. Write expressions for the surface and volume of a cone of revolution.

GEOMETRY.

SEPTEMBER, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Through any three points not in the same straight line a circumference can be made to pass, and but one.

2. If three or more straight lines drawn through the same point intersect two parallels, the corresponding segments of the parallels are proportional.

3. To find the locus of all the points whose distances from two given points are in a given ratio.

4. Define the term *limit*. Prove that the circumference of a circle is the limit to which the perimeters of the inscribed and circumscribed regular polygons approach when the number of their sides is increased indefinitely.

5. (*a*) When is a straight line said to be perpendicular to a plane? (*b*) How do you measure the diedral angles included between two intersecting planes?

(*c*) Prove that if a straight line is perpendicular to a plane, every plane passing through the line is also perpendicular to that plane.

6. The volume of any parallelopiped is equal to the product of its base by its altitude.

7. If two triangles on the same sphere are mutually equiangular they are also mutually equilateral; and are either equal or symmetrical.

8. The lateral area of a frustum of a cone of revolution is equal to the half sum of the circumferences of its bases multiplied by its slant height.

ENGLISH GRAMMAR.

JUNE, 1881.

1. Mention the various classes of pronouns, and give the names f the pronouns belonging to each class.

2. How many conjugations of the verb are there, and how are ıey distinguished?

3. Parse the following sentence:

The friends, upon whom he had once relied, were now become s bitterest enemies; in one alone had he not been disappointed.

ALGEBRA.

JUNE, 1881.

NOTE 1.—Candidates for examination in this subject as a whole, should take e whole of this paper; those for the first year's partial examination, the first ırt of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on ıe subject and to what extent.

I.

1. Find the greatest common divisor of

$$5a^5+10a^4b+5a^3b^2 \text{ and } a^3b+2a^2b^2+2ab^3+b^4.$$

2. Given $\frac{13m-7x}{m+p}+\frac{4m-x}{m-p}=\frac{m+p}{m-p}-kx$, to find x.

3. Two masons A and B propose to build a wall. If both work ogether they can finish it in 12 days; but if A work 2 days and B 3 days they will complete only one-fifth of the job. How long will it take each of them separately to do the work?

4. (*a*) Reduce $\sqrt[p]{a}$, $\sqrt[q]{b}$, $\sqrt[r]{c^2}$ to the same index.

(*b*) Simplify the following expressions:

(1.) $\sqrt[3]{8a\,\sqrt[3m]{a^{4m}b}}$. (2.) $4\sqrt{48}+\sqrt{147}-4\sqrt{12}$.

(3.) $\dfrac{(2)^{\frac{2}{3}}(9)^{\frac{1}{2}}(3)^{\frac{1}{3}}}{(3)^{\frac{5}{3}}(4)^{\frac{1}{2}}(2)^{\frac{1}{2}}}$.

5. Given $2\sqrt{2x+2}+\sqrt{x+2}=\dfrac{12x+4}{\sqrt{8x+8}}$ to find x.

II.

6. Given $4x-\frac{36-x}{x}=46$ to find x.

7. Determine by inspection the roots of the equation

$$x^2-(a+b)x+(a+c)(b-c)=0,$$

and state the principle upon which you do so.

8. Given $x^2y+xy^2=a$ and $x^2y-xy^2=b$, to find x and y.

9. Expand $(a^3+b^3)^{\frac{1}{3}}$ to four terms by the binomial formula.

10. Show that the modulus of any system of logarithms is equal to the reciprocal of the Naperian logarithm of the base of the system; and also that it is equal to the logarithm of the Naperian base taken in the system.

ALGEBRA.

SEPTEMBER, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Resolve a^6-b^6 into four factors.

2. Given $\frac{7}{\sqrt{x}}+\frac{4}{\sqrt{y}}=4$ and $\frac{1}{\sqrt{x}}+\frac{2}{\sqrt{y}}=1$, to find x and y.

3. Simplify the following expressions:

(1.) $\frac{a^{\frac{2}{3}}}{a^{-\frac{3}{4}}}$; (2). $\left(a^{\frac{2}{4}}\right)^5$; (3). $\sqrt[4]{a^{\frac{2}{3}}}$; (4). $\sqrt[2]{\sqrt[3]{5ab^6}}$;

(5). $\sqrt{\frac{2}{-2}}$; (6). $\frac{\sqrt{2}}{\sqrt[2]{2}}$.

4. Resolve the trinomial $x^2+2x-120$ into its binomial factors.

5. Given $\frac{\sqrt{3x^2-1}+\sqrt{3-x^2}}{\sqrt{3x^2-1}-\sqrt{3-x^2}}=\frac{a}{b}$ to find x.

6. Given $5x^2+2y^2=22$ and $3x^2-5y^2=7$, to find x and y.

7. A ball rolls down an inclined plane, describing one foot the first second, three feet the second, and so on. How far will it go in 10 seconds, and how far in the 10th second?

8. If the population of a certain city is now 10,000 and it increases at the annual rate of 10 per cent. for the next 10 years, what will it be at the end of that time. [Given $(1.1)^{10}=2.5937+$].

9. Expand $\frac{2+3x}{4+5x}$ into a series by the method of indeterminate coefficients.

10. Find the number of combinations of 10 things taken 4 together, and also taken 6 together.

TRIGONOMETRY.

JUNE, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Write the values of the different trigonometric functions for ngles of 0°, 90°, 180°, 270°, 300°.

2. Write the simplest equivalent expressions for

$$\sin\left(\frac{\pi}{2}-a\right),\ \cos\left(\frac{\pi}{2}+a\right),\ \tan\left(\frac{3}{2}\pi-a\right),\ \sin(2\pi-a).$$

3. Write the fundamental formulæ connecting two or more of he trigonometric functions of the same angle, and deduce any wo of them.

4. Given $\tan a=\frac{m}{n}$, to find $\sin a$ and $\cos a$.

5. Deduce the formulæ

$$\cos 2a=1-2\sin^2 a;\ \sin\tfrac{1}{2}a=\sqrt{\tfrac{1}{2}(1-\cos a)}.$$

6. Prove that $\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{3}=\frac{\pi}{4}$.

7. In a plane triangle the side a is 4575, the side b is 5656.7 ınd the angle B (opposite b) is 125° 25′; find the remaining parts ɔf the triangle.

TRIGONOMETRY.

SEPTEMBER, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Find the angle 1.8 in degrees.

2. Calculate the different functions of $\frac{\pi}{6}$ and $\frac{11}{6}\pi$.

3. Represent the different trigonometric functions of an angle in the second quadrant by lines.

4. Deduce the formula

$\cos a-\cos b=-2\sin\frac{1}{2}(a+b)\sin\frac{1}{2}(a-b)$, a and b being any angles.

5. Given $\tan\theta=\frac{m}{n}$ to find the value of $m\cos 2\theta+n\sin 2\theta$.

6. In a triangle A B C given the sides a, b, and c respectively opposite the angles A, B, and C, as follows: $a=766.3$ $b=872$ $c=565.05$ *to find the angle A.*

LATIN.

JUNE, 1881.

I. Translate as literally as possible—

a. Ei legationi Ariovistus respondit: Si quid ipsi a Caesare *opus* esset, sese ad eum venturum fuisse; si quid ille se velit, illum ad se venire oportere. Praeterea se neque sine exercitu in eas partes Galliae venire audere, quas Caesar possideret, neque exercitum sine magno commeatu atque molimento in unum locum contrahere *posse.*

b. Hac re statim Caesar per speculatores cognita, insidias veritus, quod, *qua* de causa discederent, nondum perspexerat, exercitum equitatumque *castris* continuit. Prima luce, confirmata re ab exploratoribus, omnem equitatum, qui novissimum agmen moraretur, praemisit.

c. Erant ejusmodi fere situs oppidorum, ut posita in extremis lingulis promontoriisque, neque *pedibus* aditum haberent, quum ex alto *se* aestus incitavisset, quod bis accidit semper horarum viginti quattuor spatio, neque navibus, quod rursus minuente aestu naves in vadis afflictarentur.

d. Quod ubi Caesar comperit, omnibus his rebus confectis, quarum rerum causa transducere exercitum constituerat, ut *Germanis* metum injiceret, ut Sigambros ulcisceretur, ut Ubios *obsidione* liberaret, diebus omnino decem et octo trans Rhenum consumptis, satis et ad laudem et ad utilitatem profectum arbitratus, se in Galliam recepit pontemque rescidit.

e. Nostri, acriter in eos impetu facto, repulerunt, neque finem *sequendi* fecerunt, quoad *subsidio* confisi equites, quum post se legiones viderent, praecipites hostes egerunt, magnoque eorum numero interfecto, neque sui colligendi neque consistendi aut ex essedis desiliendi facultatem dederunt.

f. At in ejusmodi difficultatibus, quantum diligentia provideri poterat, providebatur, ut potius in nocendo aliquid praetermitteretur, etsi omnium animi ad *ulciscendum* ardebant, quam cum aliquo militum detrimento *noceretur.*

II. 1. Decline *situs* (12), *pedibus* (13), *vadis* (16).

2. Compare *prima* (9), *acriter* (23), *potius* (29).

3. Write the synopsis, active and passive, of *perspexerat* (8).

4. State the mood and tense of the following: *velit* (2), *morar* (11), *accidit* (14), *viderent* (25), *dederunt* (27).
5. Give the principal parts of the following: *respondit* (1), *ere* (4), *contrahere* (6), *veritus* (8), *continuit* (9), *moraretur* , *posita* (12), *comperit* (17), *ulcisceretur* (19), *recepit* (22), *idit* (22), *confisi* (24).
6. State the construction of all italicized words.
7. Define indirect statement (*oratio obliqua*), and quote an mple from the above text.
8. Convert into direct statement (*oratio directa*) the example ted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1881.

. The horsemen[1] of Ariovistus hurl[2] stones[3] and[4] darts[5] at[6] the nans.
. Stones and darts are hurled at the Romans by the horsemen Ariovistus.
It was reported[7] to Caesar (that) the horsemen of Ariovistus e hurling stones and darts at the Romans.
(Rewrite sentence third so as to illustrate direct statement.)
. It was reported to Caesar (that) the horsemen of Ariovistus hurled stones and javelins at the Romans.
. (Rewrite sentence fifth so as to illustrate direct statement.)
. When[8] it had been reported to Caesar, (that) the horsemen of iovistus were hurling stones and javelins at the Romans, he de[9] an end[10] of speaking.[11]

[1] eques.
[2] conjicere.
[3] lapis.
[4] que.
[5] telum.
[6] in.
[7] nuntiare.
[8] quum, with subjunctive.
[9] facere.
[10] finis.
[11] loqui.

LATIN.

SEPTEMBER, 1881.

I. Translate as literally as possible—

a. Eodem die ab exploratoribus certior factus hostes sub monte consedisse millia *passuum* ab ipsius castris octo, qualis esset natura montis et qualis in circuitu ascensus, qui cognoscerent, misit. Renuntiatum est, *facilem* esse. De tertia vigilia Titum Labienum, legatum pro praetore, cum duabus legionibus et iis ducibus, qui iter cognoverant, summum jugum montis ascendere jubet.

b. Hoc proelio facto et prope ad internecionem gente ac nomine Nerviorum redacto, majores *natu*, quos una cum pueris mulieribusque in *aestuaria* ac paludes collectos dixeramus, hac pugna nuntiata, quum victoribus nihil impeditum, victis nihil tutum arbitrarentur, omnium, qui supererant, consensu legatos ad Caesarem miserunt seque ei dediderunt.

c. Hostes undique circumventi, desperatis omnibus rebus, se per munitiones dejicere et *fuga* salutem petere intenderunt. Quos equitatus apertissimis campis consectatus, ex millium quinquaginta numero, quae ex Aquitania Cantabrisque convenisse constabat, vix quarta parte relicta, multa *nocte* se in castra recepit.

d. Reliquum exercitum Quinto Titurio Sabino et Lucio Aurunculeio Cottae, *legatis*, in Menapios atque in eos pagos Morinorum, ab quibus ad eum legati non venerant, *ducendum* dedit. Publium Sulpicium Rufum legatum, cum eo praesidio quod satis esse arbitrabatur, portum tenere jussit.

e. Equites hostium essedariique acriter *proelio* cum equitatu nostro in itinere conflixerunt, ita tamen ut nostri omnibus *partibus* superiores fuerint atque eos in silvas collesque compulerint; sed, compluribus interfectis, cupidius insecuti nonnullos ex suis amiserunt.

f. Cum his esse hospitium Ambiorigi sciebat; item per Treviros venisse *Germanis* in amicitiam cognoverat. Haec prius *illi* detrahenda auxilia existimabat, quam ipsum bello lacesseret; ne desperata salute aut se in Menapios abderet, aut cum Transrhenanis congredi cogeretur.

II. 1. Decline *millia* (2), *ducibus* (8), jugum (8).

2. Compare *summum* (6), *tutum* (12), *cupidius* (28).

3. Write the synopsis, active and passive, of *misit* (4).

4. State the mood and tense of the following: *supererant* (12), *intenderunt* (15), *recepit* (19), *tenere* (24), *compulerint* (28).

5. Give the principal parts of the following: *ascendere* (7), *edacto* (9), *dediderunt* (13), *dejicere* (15), *petere* (15), *relicta* (18), *onflixerunt* (26), *compulerint* (28), *detrahenda* (32), *lacesseret* 33), *abderet* (33), *congredi* (34).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an xample from the above text.

8. Convert into direct statement (*oratio directa*) the example uoted in answer to question seventh.

LATIN EXERCISES.

SEPTEMBER, 1881.

1. The Ubii[1] kill[2] a great[3] number[4] of the Suevi.[5]

2. A great number of the Suevi are killed by the Ubii.

3. The Ubii pursued[6] the terrified[7] Suevi.

4. The terrified Suevi were pursued by the Ubii.

5. The Ubii, having pursued the terrified Suevi, killed a great umber of them.

6. It was reported[8] to Caesar (that) the Ubii had killed a great umber of the Suevi.

7. (Rewrite sentence sixth so as to illustrate direct statement.)

8. It was reported to Caesar (that) the Ubii were pursuing the ievi.

9. (Rewrite sentence eighth so as to illustrate direct statement.)

[1] Ubii.
[2] occidere.
[3] magnus.
[4] numerus.
[5] Suevi.
[6] insequi.
[7] perterritus.
[8] nuntiare.

HISTORY OF THE UNITED STATES.

JULY, 1881.

1. When and where did the Spaniards make their first permanent settlement in North America? the English? the French?

2. State the causes and the results of the French and Indian War.

3. Arrange the following events in the order in which they occurred, with their dates: Election of John Adams, settlement of Georgia, battle of Gettysburg, introduction of slavery, assembling of the Second Continental Congress, opening of the Pacific Railroad, annexation of Texas.

4. Sketch the career of Benjamin Franklin; of Abraham Lincoln.

5. What was the Fugitive Slave law?

6. Who was President in 1803? in 1843? in 1873?

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1881.

1. Sketch the settlement founded by Roger Williams; by James Oglethorpe.

2. How were the Colonies governed before the Revolution?

3. Arrange the following events in the order in which they occurred, with their dates: impeachment of Andrew Johnson, surrender of Burgoyne, introduction of the Telegraph, Lincoln's Emancipation Proclamation, battle of New Orleans, purchase of Louisiana, death of Washington.

4. Give the names of the opposing political parties in 1800; in 1868.

5. When was the Constitution adopted?

6. Sketch the administration of Monroe; Fillmore.

GEOGRAPHY.

JULY, 1881.

1. Bound the state of Tennessee; name two cities in the state and tell how and where they are situated.

2. What states of the United States touch Lake Erie; what large cities are situated on it and in what states are they?

3. Where are the Cascade Mountains; what river or rivers break through them; name some peaks in them; in what states or territories are they?

4. What is the Torrid Zone; about how many English miles wide is it; name three cities in it and tell where they are situated.

5. Where does the River Rhine rise, what direction does it run, where does it empty, and what countries does it touch?

6. Where are the following cities: — Baltimore, Singapore, Havana, Manilla, Detroit?

GEOGRAPHY.

SEPTEMBER, 1881.

1. Bound the state of Missouri; name its largest city and tell how it is situated.

2. What states and territories of the United States touch British America or the Great Lakes through which the boundary runs—name them in their order beginning with Maine, and passing west.

3. Describe the Russian Empire, its position, its capital, its principal rivers.

4. Where does the River Oronoco rise, what is its course, where does it empty and what countries does it touch?

5. Where are the following cities:—Glasgow, Bombay, Valparaiso, Rochester, Bremen?

6. What countries surround the Mediterranean Sea, and where is each one located?

SEVENTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1882-83.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1883.

STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

HIS EXCELLENCY HOBART B. BIGELOW, New Haven.

Lieutenant-Governor.

HIS HONOR WILLIAM H. BULKELEY, Hartford.

State Senators.

HON. JOHN P. HILLS, Hartford.
HON. ROBERT COIT, New London.
HON. ANDREW S. UPSON, Farmington.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

REPORT

OF THE

STATE BOARD OF VISITORS.

the General Assembly of the State of Connecticut:

n accordance with the requirements of the statutes of State, the State Board of Visitors of the Sheffield entific School herewith present the Annual Report of Governing Board of that School.

The history of this establishment of learning has been of steady and increasing usefulness and success. It is its purposes, and in the kind of work which it under- es, peculiarly adapted to the wants of our State. We preëminently an industrial community, but industrial in se departments which are based upon the most extended lies of natural science, and upon the application of the st recent results of these studies. Consequently it is e that a school devoted to the pursuit and encourage- nt of such studies finds its natural field. During the ar just closed there has been no material change in the dition or prospects of the School. Its body of instruc- s has remained the same, and the number of students somewhat increased. There is no need to call attention un to the high efficiency and devotion to their work ich mark these instructors. The results as set forth in eir report are their sufficient proof.

The past year has, however, been marked by one los deplorable in many aspects, but especially to be regrette by the friends and managers of the Sheffield Scientif School, in the death of the founder, Joseph E. Sheffiel Esq., who died in February. Owing its existence as a we equipped establishment to the intelligent generosity of M Sheffield, it has met with his encouragement, and with h liberal assistance at every stage of its growth. By h liberality Mr. Sheffield earned, not only the gratitude o those who may be trained in this school, but the permanen recognition by the State of his public spirit and far-seein appreciation of the wants of our people. A full account o his connection with the school is found in the report. I may, we hope, be an encouragement to other generous minded citizens of our State to continue and still mor develop the work so successfully commenced.

HOBART B. BIGELOW,

Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Seventeenth Annual Report the Governing Board are again enabled to announce the increasing prosperity of the Sheffield Scientific School, so far certainly as this is indicated by the numbers in attendance. The expectation of possible growth in this way, expressed in the Report of two years ago, have been more than realized. The increase is not only a steady one, but one of its most striking peculiarities is that it is confined to no section of the country. A tabular statement has been prepared, and will be found on a subsequent page, from which it will be seen how widely scattered is the constituency from which the Scientific School draws its representatives.

In another respect the school has suffered a loss which while inevitable in the course of nature was none the less to be regretted when it came. On the 16th of February, 1882, after a short illness died the great benefactor of the school, Joseph E. Sheffield, who may be justly styled its founder. The public press has commemorated the various services of his long and honored life; and in a funeral oration delivered in the College Chapel on the evening of June 26th, during the Commencement week of 1882, the President of the University delivered a funeral oration in which he narrated the life of the most generous and disinterested benefactor which the cause of scientific education has ever known, and paid a full tribute to his many high qualities. It may be, however, proper for us to repeat briefly the story of Mr. Sheffield's connection with the school which is proud to bear his name, and to give a brief outline of the motives which induced him *first to take an interest* in it and of the feelings with *which he came to regard it.*

The attention of Mr. Sheffield was originally directed to the Scientific School by his son-in-law, Professor John A. Porter. After the lamented death of Professor Norton in 1852, Mr. Porter, who had been professor of Chemistry in Brown University, consented to take temporary charge of the Yale Analytical Laboratory, and this ultimately led to his becoming permanently attached to the school of science which has grown out of it. From the very outset he was warmly interested in its success, and spared neither time nor labor to increase directly its efficiency and arouse the interest of others in its welfare. Beside his scientific attainments Professor Porter was a man of far more than ordinary cultivation in letters: and it was the union of these qualities rarely found in conjunction that enabled him to be of the most indispensable service to the success of the school in its feeble beginnings. To the public he became, while the state of his health allowed him to take an active part in its affairs, the leading agent in making known its needs and the leading exponent of its policy. It was his warm interest and active interposition in behalf of the school then without any endowment that led Mr. Sheffield originally to take an interest in its affairs. In 1854 the latter made a contribution of five thousand dollars, and this was the beginning of a long series of gifts which increased steadily in size as time went on. To it he added in 1856 another subscription of five thousand dollars in response to an effort that was then making to put this department of Yale College on a more satisfactory basis. About this time he acquired the property on Hillhouse avenue on which he subsequently resided, and offered that portion of it lying on the corner of Grove street, whenever money enough was raised to erect a building for the use of the Scientific School.

The effort to raise money for this purpose was unsuccessful. The institution was, in fact, in a far from satisfactory condition either as regards efficiency or permanence. A want of adequate accommodation was its most pressing need; and on being informed of this fact, by Professor Porter, Mr. Sheffield while in Europe entered into negotiations for the purchase of the building occupied by the Medical department of the college, which he purposed to give to the Scientific School. The negotiations were successful, and upon his return to this country in 1858 the whole matter was consummated. It soon became apparent, however, *that* additions and alterations were necessary, that a proper

oratory was needed, and for these objects there was no money the hands of the Corporation of the College.

Impressed with the importance of having the building he had rchased and presented to the Corporation, thoroughly reno-ted and made available for the use of the school, Mr. Sheffield solicited addressed a note to the Trustees of Yale College, ating that he would pay for all improvements that were needed put the building in thorough order for carrying out the objects which it was designed. He went even further than this. No ner was the building completed and occupied than he saw at ce that this was not enough; that an endowment was needed secure its success. He did not wait long to remedy a defect ich was discovered by his own practical sagacity and not sug-sted by any who were interested in the welfare of this institu-n. To his two previous endowments of five thousand dollars accordingly added enough to make the whole sum fifty thou-d dollars, and this he directed to be employed in the part intenance of the professorships of Engineering, Metallurgy d Chemistry. These united benefactions amounted to over e hundred thousand dollars, and constituted at the time the gest gift the college had then ever received from any one rce. They came too at a critical time. They put the School a period when scientific institutions throughout the country re in a struggling state, in a comparatively independent posi-n; and the institution, as a consequence, entered at once upon t career of prosperity which it has since enjoyed.

t was these benefactions that led the Corporation to ask ough President Woolsey that they might give to this depart-nt of the college, which he had so liberally assisted, the name the Sheffield Scientific School. The proposition, "flattering it was," wrote Mr. Sheffield, "I respectfully declined, for the son (in my own mind) it might deter some of our wealthy izens from making a much larger provision for this department t growing in importance and in favor." After renewed re-sts of this sort he finally gave his consent to its being named m him, and in 1861 it received from the Corporation the title the Sheffield Scientific School.

n 1862 Congress passed the bill appropriating to each State a tain portion of the public lands for the purpose of encouraging truction in mechanical and agricultural science. The legis-ure of Connecticut *authorized* the income from the fund de-

rived from this source to be given to the school of science s established here; and in order to carry out the objects grant still further, Mr. Sheffield, who never once lost sight interests of the institution, enlarged and equipped at an e of fifty thousand dollars the building he had originally pu and presented. Besides these, numerous other gifts for objects were made from time to time and can be found re in the various reports that have been made to the legis His interest in the institution, indeed, kept steadily deepe the very end of his life. Nor did he fail to maintain a w eye over its affairs, or to keep himself thoroughly informe its condition. Whenever it needed fresh facilities in conse of its success in attracting students, he came at once to its s not merely without solicitation but often when those en with its management were unaware that he was acquainte its necessities. A striking proof of this was seen in 187 he unexpectedly gave directions for the erection and equip a new hall, the present North Sheffield Hall. The number dents had at that time so increased that the accommodation command of the Governing Board were inadequate to c the work desired. The first notice that body had of his a ation of the situation was a note directing the trustees to d estimates of a building of the character and size required.

It was about this time also that Mr. Sheffield form plan of having a body of trustees of his own to ca more specifically the objects he had in view. Accordi February, 1871, he caused to be organized a body trustees, to whom he conveyed the piece of land on he purposed to build a hall, together with large donat money. Three of these trustees, by the original act of poration, were to be permanent professors of the scho Governor of the State, the President of Yale College, a Chairman of the Trustees of the Peabody Museum, were e to belong to the board. The original board consisted sequence of the then Governor of the State; the Presi the College; Professor Dana, the Chairman of the Trus the Peabody Museum; John S. Beach of New Haven, Walter Phelps of New York, and Charles J. Sheffield of land, Ohio, and the three following professors in the Sc *School*: George J. Brush, Daniel C. Gilman and Will *Trowbridge*. They were originally incorporated under t *eral act*. Since that time the place of Professor Gilman

taken by Professor Brewer, that of Professor Trowbridge by Professor Lounsbury. In other respects there has been no change in the board.

The various specific gifts of Mr. Sheffield can be found recorded, as has already been observed, in the Annual Reports of the preceding years, at least so far as was permitted by the unwillingness he ever manifested to have publicly known what he gave. Of this kind it is perhaps sufficient to say that for a number of years he gave directly ten thousand dollars a year for current expenses, and in the last year of his life this sum he increased to twenty thousand. The value of the gifts he has made at various times amounted at his death to about five hundred thousand dollars. By his will he put the institution on the same basis as his children, and one-seventh of the property fell in consequence to its share. It is impossible to state now what will be the precise sum that under the terms of the bequest will become the property of the Scientific School, but it is sufficiently near the truth to state that it will probably amount to half a million of dollars. It was left entirely unencumbered. Mr. Sheffield in this, as in all the contributions he made, recognized the impolicy of tying up gifts to educational institutions with conditions. The records of benevolent enterprises of all kinds will, in fact, show the name of no man who cared less than the founder of the Scientific School for what contributed to his own personal reputation. His gifts were not inspired in the slightest by the vanity of benevolence, but by a generous desire to furnish to those who were to come after the means of thorough preparation for the new duties which the new conditions of modern life demand. His whole conduct in connection with the institution was governed entirely by a disinterested zeal in behalf of higher education, which is rare even among those who have made great contributions to advance it, and by a clear-sighted judgment, often entirely unknown to men even of great cultivation, which recognized the fact that schools of learning can only be successfully managed by those who know what learning is. Friends and patrons, it is to be hoped, will come forward in the future to increase the resources and enlarge the usefulness of an institution which is still prevented from accomplishing much that is of first importance by the inadequacy of the means at its command. But its fortune will be peculiarly happy if the same generous and disinterested spirit which animated its founder, shall *influence the men* who are disposed to carry on the *work he began.*

Renewal of the Charter.

In consequence of certain changes which had been made in codifying the laws of the State, it was thought desirable by Mr. Sheffield that instead of being organized under a general statute, a special charter should be asked for from the legislature incorporating the Board of Trustees of the Scientific School. On the motion of President Porter, therefore, at a meeting held Nov. 22, 1881, Mr. John S. Beach was requested to prepare the draft of a charter which should be presented to the legislature for their action. This was accordingly done. Before the matter could be brought before the legislature, however, Mr. Sheffield had died. It was passed in the Senate without a dissenting vote; and the House of Representatives not only passed it with the same unanimity, but on the motion of the Hon. Mr. Cleveland of Brooklyn, passed it with a rising vote. It was a tribute of respect, equally creditable to the memory of the man to whom it was paid, and to the representatives of the State who paid it.

Addition to the Corps of Permanent Professors.

The school has been fortunate during the past year in adding to the corps of its permanent officers Russell H. Chittenden as occupant of the newly-founded Chair of Physiological Chemistry. Mr. Chittenden was a graduate of the institution in the class of 1875. After graduation he remained pursuing a course of special study in Physiological Chemistry; and on account of the proficiency he displayed in this particular subject was almost immediately made instructor in it, and had the main charge of the laboratory of Physiological Chemistry until 1878. He then went to Germany and studied Chemistry and Physiology in the University of Heidelberg. Returning he again resumed charge of the Physiological Laboratory, and in 1880 received from Yale College the degree of Doctor of Philosophy. The summer of 1882 he went to Germany by request to carry on an investigation in Physiological Chemistry with Professor Kühne of Heidelberg. During his absence he was elected to the chair above-mentioned by the Corporation of Yale College at their *meeting* in Commencement week.

States represented in the School.

n previous part of the report attention has been called to rge extent of country from which the Scientific School its students—a characteristic which is steadily becoming narked as time goes on. The following table will show the from which come the students whose names appear on the gue during the current year, and of the proportion of num- nat belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
fornia	--	--	--	1	--	1
rado	--	1	2	--	--	3
necticut	8	20	23	27	4	82
rict of Columbia,	--	--	1	--	--	1
ida	--	2	--	--	--	2
rgia	--	--	--	--	1	1
ois	--	5	2	3	--	10
ana	--	--	1	2	--	3
a	--	--	1	--	--	1
tucky	--	--	--	2	--	2
ne	1	--	1	2	--	4
sachusetts	1	4	--	1	--	6
igan	--	--	--	1	--	1
esota	--	--	--	1	--	1
ouri	--	--	1	4	--	5
raska	--	--	--	1	--	1
Hampshire	--	--	--	1	--	1
Jersey	--	1	1	2	--	4
York	5	7	12	20	1	45
	1	2	2	3	--	8
on	--	--	--	2	--	2
sylvania	1	3	5	7	--	16
h Carolina	--	1	--	--	--	1
inia	--	--	--	2	--	2
onsin	--	1	--	--	--	1
. of Colombia	--	--	--	1	--	1
a Scotia	1	--	--	--	--	1
ey	1	--	--	--	--	1
Totals,	19	47	52	83	6	207

Additions to the list of gifts to the Department of Dynamical Engineering, S. S. S.

The Ashcroft Manufacturing Co., New York, a nickel plated "Tabor" Steam Engine Indicator, in ebony box, with extra springs and scales. A beautiful and very accurate instrument.

The Harper Steam Lubricator Co., Westville, a nickel plated drop lubricator, mounted upon steam pipe.

Henry R. Worthington & Co., New York, a Worthington Steam Pump for feeding boiler or working against heavy pressure. This pump is in complete working order, and will be particularly valuable to the students as showing a type distinct from those mentioned before.

Public Lectures.

The sixteenth annual course of lectures to mechanics and others has been given during the past year. The lecturers and their subjects are indicated in the annexed programme:

I.	Tuesday, Feb.	14.—The History of Geography.	Prof. Brewer.
II.	Thursday, "	16.—Leonardo da Vinci.	Prof. D. Cady Eaton.
III.	Tuesday, "	21.—Science and Faith.	Prof. DuBois.
IV.	Thursday, "	23.—The Building Stones of Connecticut.	Mr. H. W. Lindsley.
V.	Tuesday, "	28.—The History of Geography.	Prof. Brewer.
VI.	Thursday, Mar.	2.—Pine Trees and Pine Cones.	Prof. Daniel C. Eaton.
VII.	Tuesday, "	7.—Milk.	Dr. E. H. Jenkins.
VIII.	Thursday, "	9.—Mechanical Force, Nerve Force, Mind Force.	President Porter.
IX.	Tuesday, "	14.—Anecdotes of History.	Prof. Arthur M. Wheeler.
X.	Thursday, "	16.—What is a Contract?	Prof. Johnson T. Platt.
XI.	Tuesday, "	21.—Mammoth Cave.	Rev. H. C. Hovey.
XII.	Thursday, "	23.—Artificial Propagation and Culture of Fish.	Prof. Verrill.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willetts Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1881–82. The order and subjects of the Lectures were as follows:

I. Monday, Feb. 20.—Strategy and Grand Tactics.
Capt. C. W. Raymond, U. S. Engineers.
II. Friday, " 24.—Logistics. Lieut. F. V. Abbot, U. S. Engineers.
III. Monday, " 27.—Small Arms and their influence on Tactics.
Lieut. Eugene Griffin, U. S. Engineers.
IV. Friday, Mar. 3.—Artillery. Capt. J. C. Mallory, U. S. Engineers.
V. Monday, " 6.—Fortification. Capt. A. M. Miller, U. S Engineers.
VI. Friday, " 10.—Sea Coast Defence.
General H. L. Abbot, U. S. Engineers.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

The most important additions to the Zoological collections have been due, as in several previous years, to the coöperation of the curator with the U. S. Fish Commission in the exploration of the sea-bottom, off our coasts, during the summer vacation.

The headquarters of the Commission were, last season, at Wood's Holl, Mass., as in 1881, and the work of dredging and trawling was continued from that point over an extensive region, extending about 160 miles, east and west, along the Gulf Stream slope, from 60 to 125 miles off shore, and to a depth of 780 fathoms.

This year, as in 1880 and 1881, the steamer "Fish Hawk," Lieut. Z. L. Tanner, U. S. N., commander, was employed in these expeditions. In the explorations, last season, the curator was specially assisted by Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. J. H. Emerton, Professor L. A. Lee, of Bowdoin College, and by Messrs. B. F. Koons, Professor E. Linton, and H. L. Bruner, of the Sheffield Scientific School.

Miss K. J. Bush and Miss Belle Voorhees have been employed, during the year, at the expense of the U. S. Fish Commission, to

aid the curator in assorting, arranging and cataloguing the extensive collections that have accumulated in connection with the explorations along our coast.

The extensive collections of Invertebrata, obtained during these several explorations, have been sent to our Museum to be reported upon and distributed. As fast as this can be done, good series will be deposited in the Museum. During the present year, large numbers of those that have been worked up have been labeled and sent to the National Museum, at Washington. Many of these are for their permanent collection, but large numbers are duplicates, to be made up into sets for distribution to other educational institutions.

The curator has published, during the year, several papers in the American Journal of Science, and Proc. National Museum, giving accounts of numerous new and interesting Invertebrata, dredged in the deep water off our coast, and has published in the Trans. Conn. Academy, vol. v, a "Catalogue of the marine Mollusca added to the fauna of New England during the past ten years," with five plates, and in vol. iv, a paper on New England Annelida, with ten plates. He has also prepared a report on the deep-water Anthozoa taken off our coast by Mr. A. Agassiz, on the "Blake," and by the Fish Commission, illustrated by eight plates. This is now in press.

Professor S. I. Smith has taken charge of the Crustacea in the Museum. He has published in the Bulletin of the Museum of Comparative Zoology a report on the numerous new forms of deep-water Crustacea, dredged off our coast by Mr. A. Agassiz on the "Blake," in 1880. This report is illustrated by sixteen plates. He has also prepared for publication in the Proceedings of the National Museum a lengthy illustrated paper on the deep-water Crustacea taken by the "Fish Hawk," in 1880 to 1882.

Mr. J. H. Emerton, besides making most of the drawings for the reports named above, as well as for others in progress, has published, in the Trans. Conn. Academy, vol. vi, a monograph of the New England Spiders of the family Theridiidæ, illustrated by twenty-four plates.

Mr. Emerton has nearly finished the life-sized restoration of one of the gigantic Cephalopods of Newfoundland (*Architeuthis princeps*), for the Museum, and it has been put on exhibition. He has, also, been engaged upon two duplicates of this: one for the *Museum* of Comparative Zoology, and one for the U. S. Fi[illegible]

mmission, to be sent to the Fishery Exhibition, at London, xt spring. He has, likewise, commenced to make a model of great *Octopus* of the California Coast.

Among the additions are the following:

University Museum, Copenhagen, Denmark, through Prof. r. Lütken. A collection of Annelida. In exchange.

John Allen (S. S. S.). Nest and eggs of snow-bird (*Junco hiemalis*), from the White Mountains.

F. S. Gold, West Cornwall. Large quantity of intestinal rms (*Ascaris*), from intestine of pig.

S. W. Williston. Egg of wild goose, Lake Como.

Prof. S. F. Baird, U. S. Fish Commission. Six living German p.

A. H. Verrill, New Haven. Nest and eggs of yellow-breasted it.

Principal J. W. Dawson, Montreal. Rare marine shells, from uth of the St. Lawrence River. Deposited by A. E. Verrill.

E. A. Houghton, W. Medway, Mass. Mounted birds. Deposl by A. E. Verrill.

Albertus Baldwin, New Haven. "Butter-ball" duck, mounted. rchased.

Townsend Brothers. Oysters injured by boring sponge (*Cliona phurea*), New Haven.

Museum of Comparative Zoology. Set of deep-water Crustacea, m the "Blake Exp.," 1880, described by Professor S. I. Smith; d of Cephalopoda, described by A. E. Verrill.

Geo. W. Potter, E. Haven. Salamander (*Amblystoma punctum*).

Mr. and Mrs. D. A. Heald, New York, for the Memorial Collecon of Charles A. Heald, class of 1881, two rare and beautiful irds of Paradise.

F. S. Smith. Hammer-head shark.

H. S. Bruner. Two *Ozotheca odorata*, from Lake Saltonstall.

G. W. Potter, East Haven. One kitten. A monstrosity, with ne head, two bodies, eight legs.

Dr. J. A. Henshall, Cynthiana, Ky. Two *Moira atropos*, Indian R. Inlet, Fla.

L. C. Wooster, (S. S. S.). Fresh-water sponge from Whitewater, Wis.

Henry E. Pardee, No. 230 Chapel st., New Haven. Specimens of wood and bark excavated by bark-beetles, from Monroe, Conn.

Adam Herman. Turkey Buzzard killed in 1882, at Stonington, Conn. Purchased.

Rev. S. M. Hammond. Fossil shells bored by a fossil *Cliona* (sponge), from James City Co., Va., in marl pit.

Museum of Comparative Zoology. Four species of *Pentacrinus*, from deep water in the West Indies, Blake Expedition. Set of deep-sea, West Indian sponges, labeled by O. Schmidt, from the Blake Expedition.

N. J. Peck, Woodbridge. White Ermine, in the flesh, from Woodbridge, collected by Howard R. Baldwin.

Dr. Herman Friele, Bergen, Norway. Collection of rare Norwegian and Arctic shells. In exchange.

J. Gwyn Jeffreys, London. Several rare European, deep-sea shells. In exchange.

M'chse de Monterosata, Palermo. Rare deep-sea shells from near Palermo, Sicily. In exchange.

Anonymous. Ferret, killed in the street, New Haven. Purchased.

Lyman T. Hotchkiss. White Heron, killed in East Haven in 1882. Purchased.

Chas. H. Bunce, No. 169 James st., N. Haven. Several specimens of *Crematia forceps*, from New Haven.

Geo. Bray, New Haven. One albino mouse from New Haven, living.

A. L. Howard, New Haven. Lot of spiders from Umbagog Lake, Me.

Prof. G. T. Kennedy, Windsor, N. S. Sponges and shells from Bay of Fundy, Basin of Mines.

B. S. Barrows and J. A. Allen, (S. S. S.). Collection of marine invertebrata from Labrador. (Stearns Exp.)

G. E. Verrill. Mink, mounted. North Haven.

A. E. Verrill. Corals: *Caulastræa*, *Halysites*, etc. Deposited.

A. S. Packard. Two species myriapods: *Tygopus Whitei* Ryder, Newmarket Cave, Va.; and *Scolopendra Copei* Pack., Diamond Cave, Ky.

ANNIVERSARY.

The Exercises of the Graduating Class were held in North heffield Hall on the evening of Tuesday, June 27, 1882. The ndidates for degrees with the subjects of the graduation theses f the Bachelors of Philosophy are given in the following schedule. hose marked with an asterisk read theses in the evening.

CIVIL ENGINEERS. (3).

ANCIS OSCAR MAXSON, Ph.B., *Pensacola, Fla.*

ALTER WATSON, Ph.B., *Northampton, Mass.*

IOMAS WALLACE WRIGHT (A.M. Univ. Toronto), Ph.B., *Detroit, Mich.*

BACHELORS OF PHILOSOPHY. (36).

IORACE ELLSWORTH ANDREWS (Chemistry), *Cleveland, O.* On the Salts of Tri-acetic, Tri-propionic and Tri-butyric Acids.

LFRED WARNER ARMSTRONG (Dynamic Engineering), *Cleveland, O.* On Steam Boilers and Boiler Explosions.

ARLES NOYES BATCHELLER (Dynamic Engineering), *Wallingford, Vt.* On the Steam Engine Indicator.

ENRY JONATHAN BIDDLE (Select), *Philadelphia, Pa.* On the Black Hills of Dakota.

ANCIS HAYES BLAKE (Chemistry), *New Haven.* On the Decomposition of Boronatrocalcite by Sodium Carbonate.

ATHAN GROSS BOZEMAN (Biology), *New York City.* On the Adenoid Tissue of the Cat (*Felis domesticus*).

EDERICK CASPER (Civil Engineering), *West Meriden.* On the Hydraulic Press.

ILLIAM ANSON CHAMBERLIN (Select), *New Haven.* On Movements of Population.

ILLIAM HENRY CROCKER (Select), *San Francisco, Cal.* On the Southern Pacific Railroad.

MES JOHN DRUMMOND (Dynamic Engineering), *Winfield, Ill.* On Æerial Locomotion.

ICHARD LAWRENCE EVERIT (Civil Engineering), *New Haven.* On Dynamite.

ERBERT WALDRON FAULKNER (Dynamic Engineering), *Stamford.* Design for an original Valve Gear with Mathematical Discussion.

WILLIAM ALANSON HALL (Biology), *Morris.* On the Anatomy and Histology of the Respiratory Apparatus of the Cat (*Felis domesticus*).

LFRED EDWARD HOOKER, B.A. (Biology), *New Haven.* On the Digestive Organs of the Black Snake (*Bascanion constrictor*).

LEXANDER BRYAN JOHNSON (Biology), *Utica, N. Y.* On the Reproductive Organs of the English Sparrow (*Passer domesticus*).

EDERICK WILLIAM LA FORGE (Civil Engineering), *Waterbury.* On Water Pressure Engines.

RANK JUDSON LAMBERT (Dynamic Engineering), *New Haven.* On the Manufacture of Chilled Rolls.

*Samuel Waldron Lambert, B.A. (Biology), *New York City.* On the Renal Organs of the Black Snake (*Bascanion constrictor*).

*Norman Smith Latham (Civil Engineering), *North Manchester.* On the Electric Railway.

*Cassius Samuel Lyman (Civil Engineering), *Holyoke, Mass.* On the Holyoke Water Power.

*Sheldon Elton Minor (Civil Engineering), *Thomaston.* Review of the Pumping Works at Whitneyville, Conn.

Edward Everett Paramore (Select), *St. Louis, Mo.* On the Railway Communications of Mexico.

*Louis Valentine Pirsson (Chemistry), *New York City.* On Crystalline Fluorides produced by Reactions in a Fused Medium.

Harry Smith Pope (Select), *Jersey City, N. J.* On Pauper Legislation.

*Robert Browning Rood (Select), *Great Barrington, Mass.* On the Mounds of the United States erected by the Mound-Builders.

Charles Edward Stockder, Jr. (Biology), *West Meriden.* On the Anatomy and Histology of the Kidney of the Cat (*Felis domesticus*).

Fred Moore Strong (Chemistry), *Boston, Mass.* On Acid Barium Propionate.

Henry Taber (Dynamic Engineering), *New York City.* On Double Algebra.

Arthur Graham Thompson (Dynamic Engineering), *Milford.* On the Manufacture of Iron Wire.

Edwin Thorne (Select), *New York City.* On Glaciers.

Thomas Pearsall Thorne (Select), *Millbrook, N. Y.* On Trotting and Trotting Horses.

Walter Jay Vought (Biology), *Buffalo, N. Y.* On the Alimentary Canal of the English Sparrow (*Passer domesticus*).

Edward Loder Whittemore (Dynamic Engineering), *Rye, N. Y.* On Malleable Cast Iron.

Alfred Buckingham Willcox (Dynamic Engineering), *Chicago, Ill.* On the Westinghouse Compressed Air Brake.

Chauncey Pratt Williams, Jr. (Select), *Albany, N. Y.* On the National Banking System of the United States.

Samuel Lawrence Williams (Select), *Chicago, Ill.* On the Factory Laws of England and America.

Prizes.

At the Anniversary Exercises on June 27th the following prizes were announced:

CLASS OF 1882.

For excellence in Civil Engineering, Norman Smith Latham, and Sheldon Elton Minor.

For excellence in Dynamic Engineering, Frank Judson Lambert, and Herbert Waldron Faulkner.

For excellence in German, Frederick William LaForge.

CLASS OF 1883.

For excellence in the Mathematics of Junior Year, JOHN BARTHOLOMEW, and FREDERICK ELIJAH BEACH.

CLASS OF 1884.

For excellence in all the Studies of Freshman Year, CHARLES PERCIVAL FARQUHAR, and EDWIN MUSSER HERR, with honorable mention of GEORGE WYCKOFF CUMMINS.

For excellence in German, CHARLES PERCIVAL FARQUHAR.

For excellence in Mathematics, CHARLES PERCIVAL FARQUHAR.

For excellence in Physics, EDWARD BLAKE, CHARLES PERCIVAL FARQUHAR, and EDWIN MUSSER HERR.

For excellence in Chemistry, EDWIN MUSSER HERR.

For excellence in Mechanical Drawing, GEORGE WYCKOFF CUMMINS, EDWIN MUSSER HERR, HARRY HALL KEYES, and ALBERT LUCAS.

For excellence in English Composition, 1st Prizes, DAVENPORT GALBRAITH, CALVIN LINSLEY HARRISON, SAMUEL BROWN HAWLEY, EDWIN MUSSER HERR, and WILLIAM WALLACE NICHOLS; 2d Prizes, LAWRENCE VINCENT BENÉT, and JAMES HENRY WARNER; 3d Prizes, BENJAMIN WALES DODGE, CHARLES PERCIVAL FARQUHAR, and WILLIS LAFAYETTE PERKINS.

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1882-83.

CALENDAR.

1882.		
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.
1883.		**Winter Vacation of three weeks**
11 Jan.	Thursday,	Second Term begins.
21 March,	Wednesday,	Spring Recess begins.
28 March,	Wednesday,	Spring Recess ends.
26 June,	Tuesday,	Meeting of Appointing Board.
26 June,	Tuesday,	Anniversary.
27 June,	Wednesday,	Commencement.
28, 29, 30 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of eleven weel
11, 12 Sept.	Tues., Wedn.,	Examination for Admission.
13 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the r
numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North
field Hall.

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·nathan Biddle, PH.B.	*Philadelphia, Pa.*	128 High st.
ɪ Casper, PH.B.	*West Meriden*	West Meriden
Holyoke Farrington, B.S. College, Me.	*Portland, Me.*	14 Lock st.
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bert Kellogg, B.A.	*New Haven*	167 George st.
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ɛvonian, Turkey College	*Aintab, Turkey*	67 Mansfield st.
heophilus Liefeld, PH.B.	*New Haven*	36 Orchard st.
cBride, B.A.	*Goshen, N. Y.*	116 College st.
Daty Munn, PH.B.	*Southington*	16 S. H.
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·ucius Penfield, PH.B.	*Catskill, N. Y.*	14 S. H.
Burr Osborne, B.A.	*New Haven*	156 Crown st.
lentine Pirsson, PH.B.	*New York City*	53 Prospect st.
·ocke Scudder, B.A.	*Great Barrington, Mass.*	4 Library st.
Vernon Silver, B.A.	*Brooklyn, N. Y.*	523 Chapel st.
ɪseph Stoddard, LL.B. bia College	*New Haven*	157 Church st.
Eldred Worcester, B.A.	*Albany, N. Y.*	60 W.

GRADUATE STUDENTS, 19.

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Charles Stewart Hall	*Warren, O.*	36 Elm st.
George Vance Harper	*Denver, Col.*	41 Trumbull st.
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Allen Hubbard	*Westfield, Mass.*	61 Prospect st.
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William Ellison Lockwood	*Stamford*	146 Dixwell av.
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John Edwards Stryker	*Catskill, N. Y.*	77 w.
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Harvey Allcutt	*Kansas City, Mo.*	55 Trumbull st.
re Davenport Bacon	*Norwich*	53 Prospect st.
:e Vincent Benét	*Washington, D. C.*	106 w.
Blake	*New Haven*	149 Temple st.
Francis Bosworth	*Milford*	387 York st.
e Russell Britton	*Cleveland, O.*	36 Elm st.
ey Rea Burr	*Portland, Me.*	63 Prospect st.
Park Campbell	*New Haven*	16 York sq.
DeWitt Carrington	*New Haven*	527 Chapel st.
Edward Carter	*New Haven*	121 Elm st.
Brainard Coit	*New London*	36 Elm st.
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dward Cooper	*Ansonia*	347 York st.
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Percival Farquhar	*York, Pa.*	289 York st.
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ort Galbraith	*Erie, Pa.*	36 Elm st.
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Linsley Harrison	*New Haven*	94 Wooster st.
ll Hatcher	*Cooper, Iowa*	12 Elm st.
Brown Hawley	*Yonkers, N. Y.*	43 College st.
Musser Herr	*Denver, Col.*	289 York st.
Henry Jennings	*Redding*	215 York st.
Crossley Johnson	*New Haven*	80 LaFayette st.
Keith, Jr.	*Chicago, Ill.*	200 York st.
Judson Kelsey	*Killingworth*	29 High st.
Hall Keyes	*Stony Creek*	276 Elm st.
Lucas	*Philadelphia, Pa.*	43 College st.
Heath Lyon, Jr.	*Brooklyn, N. Y.*	76 w.
Minor Maghee	*Evansville, Ind.*	63 Prospect st.
James Martin	*Norwich*	361 Elm st.
Howard Martin	*Clifton, N. Y.*	85 w.
Edgar Moulthrop	*New Haven*	253 North Front st.
n Wallace Nichols	*Manitou Springs, Col.*	289 York st.
Anderson Noye	*Buffalo, N. Y.*	99 Wall st.
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Powell, Jr.	*Towanda, Pa.*	43 College st.
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Andrew Lincoln Winton	*Bridgeport*	63 Prospect st.

JUNIORS, 52.

FRESHMAN CLASS.

Arthur Bronson Adams	*New Haven*	120 St. John st.
Grenville French Allen	*New Haven*	197 Temple st.
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James Arthur Atwood	*Wauregan*	167 Temple st.
John Walter Atwood	*Wauregan*	167 Temple st.
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Clarence Blakeslee	*New Haven*	316 George st.
Robert Neill Brace	*Dobbs Ferry, N. Y.*	165 Temple st.
George Tyler Brown	*Yonkers, N. Y.*	31 Temple st.
Fred Spencer Bullene	*Kansas City, Mo.*	44 Elm st.
Richard Morton Bushnell, Jr.	*Saybrook*	17 Wooster pl.
Merritt Mead Clark	*Bedford, N. Y.*	177 Temple st.
Wallace Sherman Clark	*Norfolk, Va.*	226 George st.
Arthur Chandler Coates	*Kansas City, Mo.*	40 Elm st.
Arthur Carrington Cowles	*Wallingford*	136 College st.
William Ledlie Culbert	*Brooklyn, N. Y.*	134 College st.
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Martin Juan Echeverria	*Panama, Colombia*	17 Wooster pl.
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Harry Brainard Gaylord	*New Haven*	40 Academy st.
Irving Cook Gladwin	*Sherburne, N. Y.*	74 High st.
James Richard Godman	*La Fayette, Ind.*	31 Temple st.
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David Leavitt Hough	*Fort Wayne, Ind.*	111 York st.

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son	*Belleville, N. J.*	109 York st.
ıng Judd	*Hartford*	7 Library st.
iam Kimball	*Portland, Oregon*	161 Temple st.
:rriam Kirkham	*Springfield, Mass.*	94 Grove st.
:ohn	*Chicago, Ill.*	696 State st.
	Franklin	157 Orange st.
rd Lang	*Elmira, N. Y.*	161 Temple st.
nd McAvoy	*Chicago, Ill.*	242 York st.
ckerman McCandliss	*Philadelphia, Pa.*	119 College st.
lair McDowell	*Woodlake, Ky.*	203 York st.
liam Maher	*New Haven*	305 Howard av.
evan Mangam, Jr.	*Sing Sing, N. Y.*	44 Elm st.
lward Martin	*Allentown, Pa.*	167 Temple st.
xander Meredith	*Xenia, O.*	55 Prospect st.
.er	*New Rochelle, N. Y.*	226 George st.
ncoln Mitchell	*New Haven*	121 Park st.
›rhead Montgomery	*Portland, Oregon*	36 Elm st.
›b Morgan	*New Haven*	470 Elm st.
lpheus Nettleton	*Kansas City, Mo.*	44 Elm st.
andy Newberry	*Detroit, Mich.*	464 Chapel st.
·ecber Nichols	*Yonkers, N. Y.*	31 Temple st.
is, 3d	*Philadelphia, Pa.*	74 High st.
.shington Norton, Jr.	*Louisville, Ky.*	237 Orange st.
·er	*Pittsburgh, Pa.*	31 Trumbull st.
ingham Oliver	*Pittsburgh, Pa.*	31 Trumbull st.
ındler Page	*Fair Haven*	South Quinnipiac st.
ayette Perkins	*Portland, Me.*	489 Temple st.
son Pinney	*Derby*	167 Temple st.
hill Pratt	*Elmira, N. Y.*	31 Temple st.
nour Reeve	*Dayton, O.*	61 Grove st.
awford Reid	*Lakeville*	74 High st.
	Pottstown, Pa.	489 Chapel st.
omas Richardson	*Hornellsville, N. Y.*	44 Elm st.
›dd Ross	*Belfast, Me.*	53 Prospect st.
deon Rupert	*New Market, Va.*	111 Dwight st.
:rt Sands	*New Haven*	119 Dwight st.
›n Schmidt	*New Britain*	59 Grove st.
ard Seymour	*Auburn, N. Y.*	44 Elm st.
ipley, Jr.	*Cincinnati, O.*	109 Elm st.
dfrey Snydacker	*Chicago, Ill.*	696 State st.
›me Stevens	*New Haven*	7 Wooster pl.
anSchoonhoven Thorne	*New York City*	65 Whitney av.
Townsend	*New York City*	82 Wall st.
auncey Turner	*Omaha, Nebr.*	156 Grove st.
iot Verrill	*New Haven*	148 College st.
Brewster Wheeler	*Monroe*	175 Temple st.
ward Whitehouse	*Hartford*	167 Temple st.

Willis Stoughton Williams	*Minneapolis, Minn.*	121 Park st.
Winslow Tracy Williams	*Norwich*	134 College st.
Clarence Henry Wood	*Morristown, N. J.*	120 York st.
Benjamin Elizur Wright	*Cromwell*	165 Temple st.

FRESHMEN, 83.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

George Barclay Bassett	*Watertown, N. Y.*	4 Mansfield st
John Edward Calhoun	*Cornwall*	450 Chapel st
Edward Seymour Hotchkiss	*Bridgeport*	Bridgeport
Henry Clay Johnson	*Rome, Ga.*	41 High st.
Warren A. Spalding	*New Haven*	89 Church st.
James Prior Wood	*West Haven*	2 Church st.

SPECIAL STUDENTS, 6.

SUMMARY.

GRADUATES,	19
SENIORS,	47
JUNIORS,	52
FRESHMEN,	83
SPECIAL,	6
TOTAL,	207

[EFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction
arches in the mathematical, physical, and natural sciences,
erence to the promotion and diffusion of science, and also
preparation of young men for such pursuits as require
proficiency in these departments of learning. It is one of
artments of Yale College, like the law, medical, theologi-
art schools, having its separate funds, buildings, teachers,
ulations, but governed by the Corporation of Yale Col-
ich appoints the professors and confers the degrees. It
rt, analogous to the academic department, or classical col-
l, in part, to the professional schools.

nstruction is intended for two classes of students:—

duates of this or of other Colleges, and other persons
l for advanced or special scientific study.

ndergraduates who desire a training chiefly mathematical
ntific, in less part linguistic and literary, for higher scien-
dies, or for various other occupations to which such
is suited.

II.

HISTORY AND ORGANIZATION.

School was commenced in 1847. In 1860, a convenient
; and a considerable endowment were given by Joseph E.
l, Esq., of New Haven, whose name at the repeated
of the Corporation of Yale College, was afterward
d to the foundation. Mr. Sheffield has since frequently
nificently increased his original gifts.

63, by an act of the Connecticut Legislature, the national

grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

ls in Architecture, Geometrical Drawing, Civil Engineering, Topographi-
l Engineering, and Mechanics; diagrams adapted to public lectures; in-
uments for field practice.
and Charts, topographical, hydrographical, geological, etc.
arium of Professor Brewer, and the astronomical instruments of Profes-
r Lyman, are deposited in the buildings. Professor Eaton's herbarium,
ar at hand, is freely accessible. Students also have access to the various
oratories and collections in Natural Science in the Peabody Museum.

nts are also admitted, under varying conditions, to the
and Society libraries, the College Reading Room, the
of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

special technical library of the Scientific School consists of
ive thousand volumes. Included in this is the "Hillhouse
natical Library" of twenty-four hundred volumes, collected
a long series of years by Dr. William Hillhouse, and in
rchased and presented to the Institution by Mr. Sheffield.
ogue of this collection forms a supplement to the Annual
of the Governing Board for 1870. All the prominent sci-
journals of this country and of Europe, together with the
lings of foreign academies, and of scientific societies, can be
either in this library or in the College Library to which
s have access.

V.

STRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

ons who have gone through undergraduate courses of study,
elsewhere, may avail themselves of the facilities of the
for more special professional training in the physical sci-
nd their applications, gaining in one, two, or three years
gree of BACHELOR OF PHILOSOPHY, or, in two additional
of Engineering study, that of CIVIL ENGINEER, or of
IC ENGINEER.
ngaging in studies of a less exclusively technical character,
ay become candidates for the degree of DOCTOR OF PHILOS-
The instruction in such cases will be adapted to the par-
needs and capacities of each student, and may be combined

with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, y obtain the degree of CIVIL or of DYNAMIC ENGINEER at the l of two academical years, by pursuing the following higher ırse of study and professional training.

The course of study for the degree of CIVIL ENGINEER will nprise—

. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
. Analytical Mechanics. Mechanics applied to Engineering.
. A Course of Construction and Design. Projects.
. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and actice, the candidate will be required to furnish a comprehensive port of the results of an examination into the existing condition some special line of constructive art; or to present proper evi- ınce that he has had actual charge in the field, for several onths, of construction or surveying parties, or held some respon- ble position deemed equivalent to this.

An elaborate design must also be submitted of some projected ork of construction, based upon exact data obtained from care- l surveys made by the candidate, and comprising all the requi- e calculations, and the necessary detailed drawings, and accom- nied by full specifications of the work to be done, and the quirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will mprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ ıch a portion of their time as may be deemed advisable or neces- ıry in the examination of engineering works and manufacturing stablishments, and may also have the privilege of entering upon rofessional practice, provided it is done with the knowledge and onsent of the Professor of Dynamic Engineering, and under such ircumstances as shall appear to him to be favorable to profes- ional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling, and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, or the First and Second Latin Books of the Ahn-Henn Latin Series (E. Steiger & Co., New York) are named as indicating the nature and extent of this requirement, and an acquaintance with one of these works will be required unless some satisfactory substitute is offered. In the last-named course one-third of each exercise may, if desired, be omitted.) (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar quantity of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures: Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

Algebra—Fundamental Operations, Fractions, Equations of the First Degree, with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid, and Spherical: including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's or Richards's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

For preparation in Algebra and Geometry the recently published text-books of Professor Newcomb on these subjects (Henry Holt & Co., New York, 1881), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on the Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 28, 29, 30, and on Tuesday and Wednesday, September 11, 12, 1883. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1883 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 28, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed neme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics* Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—citations. with experimental lectures. *Chemistry*—Recitations and Laboratory ctice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathetics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *any*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with lication to drawing from models and structures by measurement. Shading l tinting. Principles of orthographic projection. Reading of working drawgs and isometric construction of objects from their orthographic projections. tions.

For the Junior and Senior years the students select for themlves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative nalysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. ench.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—uantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy* Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural hemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral nalysis. *Geology*—Dana's. *Zoölogy*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis f Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's lanual. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions: Differential Calculus. *Surveying*—Field perations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawng*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographial. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves; Location of Line of Railroad, with calculations of Excavations and Embankment; Hencks's Field Book for Railroad Engineers; Searles's Field Engineering. *Civil Engineering*—Resistance of Materials; Bridges and Roofs, begun; Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs; Building Materials: Stability of Arches and Walls; Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism; Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies: Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structure; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply: Discharge of pipes. *Thermodynamics*—General Principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued; Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

ST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative sis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German.* h.

OND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quan-e Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *ology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

ST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern . Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *ic Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Botany. gy. English. French.*

OND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; res. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricul-Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *gy. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

her Geology, Mineralogy, Zoölogy, or Botany, may be made the principal some attention in each case being directed to the other three branches of al History.)

JUNIOR YEAR:

ST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative sis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe sis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory ice. *German. French.*

OND TERM—*Zoölogy*—Laboratory Practice: Recitations; Excursions (land narine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *ology*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

ST TERM—*Geology*—Dana's: Excursions. *Zoölogy*—Laboratory Practice; res; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Text-; Excursions. *French.*

OND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoölogy* boratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, ially in the Cryptogamous Orders; Botanical Literature; Essays in Descrip-Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM—*Physiology*—Huxley's; Practical Exercises. *Theoretical Chemistry*—continued. *Physiological Chemistry*—Sanderson's Handbook; Recitations and Laboratory Work. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German*. *French*.

SENIOR YEAR.

FIRST TERM—*Physiological Chemistry*—continued. *Toxicology*—Laboratory Practice and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical Exercises; Lectures and Excursions. *Geology*—Dana's Manual. *French*.

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Human Anatomy and Physiology*—Recitations. *Geology*—Dana's Manual. *Zoölogy*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French*.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Green's Short History of the English People. *French*. *German*.

SECOND TERM—*Mineralogy*—Lectures. *Astronomy*. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Green's History, continued; History of the United States. *German*. *French*.

SENIOR YEAR.

r TERM—*Geology*—Recitations and Excursions. *Zoölogy*—Lectures and ions *Linguistics*—Whitney's Life and Growth of Language. *English*—ere. *Constitutional Law of the United States. French.*

ND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science* ures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, , Dryden, Pope, Gray, and later authors. *French.*

ercises in English Composition are required during the entire e from all the students. The preparation of graduating the- among the duties of the Senior Year.

ctures on Military Science and Tactics are annually given by ral Abbot, and other officers of the Engineer Corps of the ed States Army.

AWING.—The course in drawing extends through the three . During the first term of Freshman year, the students ice free-hand drawing at the Art School building, under the tion of Professor Niemeyer, of the Yale School of the Fine

After the completion of the course in free-hand drawing, uction is given by Mr. F. R. Honey, during the second term e elementary principles of instrumental drawing, embracing entary projection drawing, Isometric drawing, and Descrip- Geometry as far as Warped Surfaces. This course is obliga- upon all.

uring the Junior and Senior years, instruction in drawing is gatory only on the students in Civil and Mechanical Engi- ng. In the former year the system of instruction embraces es and shadows, tinting, perspective, and warped surfaces. his method all the problems in Descriptive Geometry are ired to be worked out on the drawing-board instead of the k-board. The course extends through the entire year, and is r the direction of Mr. Honey.

Senior year, students are required to apply the principles of ing already obtained to works of construction, under the ral supervision of the Professors of Civil and of Dynamic ineering.

VII.

METHODS OF INSTRUCTION.

he instruction of this institution is given chiefly in small class- ns, in connection with recitations and by familiar lectures, trated by the apparatus at the command of the various

teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are suggestively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and in disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they *have* learned, and the collections they have made are considered to be of minor importance.

In Zoology excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, and his judgment is trained in choosing relative

proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

f this department, on the recommendation of the oard, are admitted by the Corporation of Yale Col- lowing degrees. They are thus conferred:

OR OF PHILOSOPHY: on those who complete any of s courses of study, passing all the examinations in manner, and presenting a graduation thesis.

graduation as Bachelor of Philosophy, including iennial Catalogues, Commencement Dinners, etc., is he person taking the degree is also an academical n it is but $5.

NGINEER and DYNAMICAL ENGINEER: The require- se degrees are stated on page 21.

OF PHILOSOPHY: The requirements for this degree page 17.

XI.

TERMS AND VACATIONS.

academic year begins Thursday, September 13, 1883. begins eleven weeks from Commencement-day and rteen weeks: the second term begins on the second January and continues until Commencement-day, g recess—usually of eight days—including Easter. , p. 2.)

XII.

EMENT IN RESPECT TO STATE STUDENTS.

rships established in this School in consequence of upon it of the Congressional grants are designed to n who are in need of pecuniary assistance in fitting r agricultural and mechanical pursuits of life. All ist be citizens of Connecticut. In case there are its than vacancies, candidates will be preferred who arent in the military or naval service of the United ext to these such as are most in need of pecuniary id the appointments will be distributed as far as mong the several counties in proportion to their The appointing Board for the current year, consist-

ing of the Board of Visitors of the State and the Secretary of the School, will meet on June 26th, 1883, and at or about the same time in the year 1884, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

APPENDIX.

ENTRANCE EXAMINATION PAPERS.

he following are the papers for 1882, upon which applicants for admission
e examined at the June and September examinations.

ARITHMETIC.

JUNE, 1882.

1. Find the greatest common divisor of 17640 and 18375.

2. Find the least common multiple of the foregoing numbers.

3. Give the table of Troy weights; also, the table of Metric weights. Express the gram in grains and the kilogram in pounds avoirdupois.

4. Express $\frac{32\frac{1}{6}}{75\frac{3}{6}}$ decimally to three places.

5. Of an alloy containing 21 parts copper and 4 parts nickel, what per cent. is copper and what per cent. nickel?

6. For what amount must a note payable in 60 days be given to a bank discounting at 6 per cent. to obtain $500.

7. If 16 men build 18 rods of wall in 12 days, how many men will be needed to build 72 rods in 8 days.

8. Extract the square root of .001601 to four places.

ARITHMETIC.

SEPTEMBER, 1882.

1. (*a*) Which of the numbers 293, 371, 385, 440, 524, 617 and 713 are prime?

(*b*) Separate 1836 into its prime factors.

2. Divide $\frac{\frac{7}{8}}{\frac{3}{11}}$ of $12\frac{1}{2}$ by $\frac{\frac{1}{3}}{7\frac{1}{2}}$ of $8\frac{3}{4}$.

3. Divide .000744 by .62, and explain the position of the decimal point in the quotient.

4. In 80937864 square inches how many acres?

5. Q and Y barter; Q makes of 10 cents $12\frac{1}{2}$ cents; Y makes of 15 cents 19 cents; which makes the most per cent., and how much?

6. Three men harvested and thrashed a field of grain on shares. A furnishing 4 hands 5 days, B 6 hands 4 days, and C 5 hands 8 days. The whole crop was 630 bushels, of which they had $\frac{1}{3}$. How much did each receive?

7. Extract the cube root of $81\frac{5}{11}$ to three decimal places.

8. Bought 30 metres of cloth at $2.50 per metre, at what price per yard must it be sold to gain $25?

GEOMETRY.

JUNE, 1882.

NOTE 1.—Candidates for examination in this subject as a whole should take whole of this paper; those for the first year's partial examination, the first : of it: those for the second year's partial examination, the second part.
NOTE 2.—State at the head of your paper what text-book you have studied on subject, and to what extent.

I.—PLANE GEOMETRY.

1. (*a*) Define and illustrate the symmetry of a figure with reference to an axis and with reference to a point. (*b*) Define the ferent classes and species of quadrilaterals.
2. The three medial lines of a triangle meet in a point which is two-thirds the distance from the vertex of each angle to the ddle of the opposite side.
3. To inscribe a circle in a given triangle. Define *escribed* cirs relative to a triangle.
4. The bisector of an interior angle of a triangle divides the posite sides into segments proportioned to the adjacent sides.
5. When is variable magnitude said to have a *limit?* Give an mple to illustrate the definition.
6. If two sides of a triangle be given, its area will be a maxim when these sides are at right angles.

II.—SOLID AND SPHERICAL GEOMETRY.

7. If a straight line is perpendicular to each of two straight es at their point of intersection, it is perpendicular to the plane these lines.
8. Define symmetrical polyhedral angles. Illustrate the definin by a figure.
9. Define the poles of a circle of a sphere. Prove that all ints on the circumference of a circle of a sphere are equally tant from each of its poles.
10. The angle between two great circles is equal to the dihedral gles between *their planes.*

GEOMETRY.

SEPTEMBER, 1882.

[State what text-book you have studied, and to what extent.]

1. An inscribed angle is measured by one-half its intercepted arc.

2. From a given point without a circle to draw a tangent to the circle.

3. To construct a triangle which shall be equal in area to a given quadrilateral.

4. The diameters of two concentric circles being 10 and 6 feet, required the area of the ring contained between their circumferences.

5. The sum of any two face angles of a trihedral angle is greater than the third.

6. The lateral area of a frustrum of a regular pyramid is equal to its slant height into half the sum of the perimeters of its bases.

7. Write expressions for the volume of the sphere and right cylinder. Show that the volume of a sphere is to that of its circumscribed cylinder as 2 to 3.

8. Required the area of a spherical triangle described on a sphere, whose diameter is 30 feet, the angles being 140°, 92°, and 68°.

ENGLISH GRAMMAR.

JUNE, 1882.

1. Define *noun* and *verb*.

2. Name the relative pronouns. State in reference to what each is used.

3. Give examples of three verbs with their principal parts from each one of the two English conjugations—the old (or strong), and the new (or weak).

4. Parse the following:—

I here declare those whom I did accuse
Are innocent. 'Tis I alone am guilty.

ALGEBRA.

JUNE, 1882.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper; those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.

1. Resolve x^3+8y^3 into two factors.

2. Given $\frac{10a-5x}{a+b}-\frac{5a-x}{a-b}=cx$, to find the value of x.

3. There are three workmen, A, B, C. A and B together can perform a certain piece of work in a days; A and C together, in b days; and B and C together, in c days. In what time could each singly perform it, and in what time could they finish it if all worked together.

4. Prove that if $\frac{a_1}{b_1}=\frac{a_2}{b_2}=\frac{a_3}{b_3}=r$, then

$$\frac{a_1+a_2+a_3}{b_1+b_2+b_3}=r.$$

5. (*a*) Write equivalent expressions for the following:

$$a^0,\ a^{-m},\ \sqrt[3]{a^5}.$$

(*b*) Reduce the following expressions to simpler forms.

(1) $\sqrt{45c^3}-\sqrt{80c^3}+\sqrt{5a^2c}$

(2) $\left[\left(\frac{a^{-2m}}{b^{-3n}}\right)^{\frac{p}{m}}\right]^{\frac{q}{2n}}$

(3) $4^3\sqrt{\frac{2}{3}}\times 2\sqrt{\frac{3}{4}}$

II.

6. Given $3x^2+x=7$, to find x.

7. Given $\frac{\sqrt{p+x}+\sqrt{p-x}}{\sqrt{x}}=\sqrt{\frac{x}{q}}$, to find x.

8. Given $x+y=a$; $x^3+y^3=b^3$, to find x and y.

9. Expand $\frac{1+2x}{1-3x}$ into a series by the method of indeterminate coefficient.

10. Write equivalent expressions adapted to computation for the following:

(1) $log\left(\frac{a^m b^n}{c^r}\right)$ (2) $\log\sqrt{a^2-x^2}$.

ALGEBRA.

SEPTEMBER, 1882.

[State what text-book you have studied on the subject, and to what extent.]

1. Multiply $\frac{x^4-b^4}{x^2+2bx+b^2}$ by $\frac{x^2+bx}{x-b}$ so as to obtain the product in its simplest form.

2. Given $x-\frac{y-a}{b}=c$ and $y-\frac{a-x}{b}=d$, to find x and y.

3. Given $\sqrt{4a+x}=2\sqrt{b+x}-\sqrt{x}$, to find x.

4. Write the 6th power of $(a-2b)$ by the binomial formula.

5. Simplify the following expressions:

$$(a)\ \left(x\frac{p}{q}\right)^n;\ (b)\ \sqrt[5]{\frac{32m^6n^{10}}{p^{15}q^{20}}};\ (c)\ \sqrt[4]{36a^2b^2};$$

$$(d)\ \sqrt{8}+\sqrt{50}-\sqrt{18};\ (e)\ 3a\sqrt[6]{b}\times 5b\sqrt{2c}.$$

6. Solve the equation $6x^2-13x+6=0$, and resolve the first member into its factors.

7. Given $x+y=p$ and $xy=q^2$, to find x and y.

8. A traveler has a journey of 132 miles to perform. He goes 27 miles the first day, 24 the second, and so on, traveling 3 miles less each day than the day before. In how many days will he complete the journey?

9. What is the present value of a dollars due n years hence, at c per cent. compound interest?

10. How many distinct straight lines can be drawn in joining two and two five distinct points, no three of which are in the same straight line?

TRIGONOMETRY.

JUNE, 1882.

[State what text-book you have studied on the subject, and to what extent.]

1. Define the different trigonometric functions of an angle.

2. Give the algebraic sign for each function of an angle terminating in each of the four quadrants.

3. Show that $\sin(\pi+\alpha)=-\sin\alpha$; and that
$$\cos(2\pi-\alpha)=\cos\alpha.$$
4. Find the formula for $\tan(\alpha+\beta)$ in terms of $\tan\alpha$ and $\tan\beta$. nd also the formula for $\tan 2\alpha$ in terms of $\tan\alpha$.
5. Given $2a\tan\theta\sin\theta-2a\cos\theta+b=0$, to find $\cos\theta$.
6. Given two sides of a plane triangle 180 and 100 and the gle opposite the former 127° 33′, to find the other parts.

TRIGONOMETRY.

SEPTEMBER, 1882.

[State what text-book you have studied, and to what extent.]

1. Find the number of degrees in the angle subtended at the ntre of a circle whose radius is 10 feet by an arc 9 inches long.
2. Determine all the functions of the following angles:
$$30°, \frac{\pi}{4}, \frac{5}{3}\pi, 585°.$$
3. Given the functions of any angle to find the functions of lf that angle.
4. Given $\tan\theta=\frac{m}{n}$ to find the value of $\sin 2\theta$.
5. Show that $2\tan^{-1}a=\tan^{-1}\frac{2a}{1-a^2}$.
6. In a plane triangle, given $a=100$, $c=200$ and $B=112°\ 30'$, find the remaining parts.

LATIN.

JUNE, 1882.

I. Translate as literally as possible—

a. Relinquebatur una per Sequănos via, *qua*, Sequănis invitis, propter angustias ire non poterant. *His* quum suā sponte persuadere non possent, legatos ad Dumnorĭgem Aeduum mittunt, ut eo deprecatore a Sequănis impetrarent.

b. Nam quod ad hostes appropinquabat, *consuetudine* suā Caesar sex legiones expeditas ducebat: post eas totius exercitus impedimenta collocarat: inde duae legiones, quae proxime

conscriptae erant, totum agmen claudebant *praesidioque impedimentis* erant.

c. Erant hae difficultates *belli gerendi*, quas supra ostendimus, sed multa Caesărem tamen ad id bellum incitabant, injuriae retentorum equitum Romanōrum, rebellio facta post deditionem, defectio datis obsidibus, tot civitatum conjuratio, imprimis, ne hac parte neglectā, reliquae nationes sibi idem licere arbitrarentur.

d. Diebus decem, quibus materia coepta erat comportari, omni opere effecto, exercitus transducitur. Caesar ad utramque partem pontis firmo praesidio relicto, in fines Sigambrōrum contendit. Interim a compluribus civitatibus ad eum legati veniunt, *quibus* pacem atque amicitiam petentibus liberaliter respondit obsidesque ad se adduci jubet.

e. Tunc duces principesque Nerviōrum, qui aliquem sermonis aditum causamque amicitiae cum Cicerōne habebant, colloqui sese velle dicunt. Factā potestate, eadem, quae Ambiōrix cum Titurio egerat, commemorant: Omnem esse in armis Galliam, Germānos *Rhenum* transisse, Caesăris reliquorumque hiberna oppugnari.

f. In omni Galliā eorum hominum, qui aliquo sunt numero atque honore, genera sunt duo; nam plebes paene servorum habetur loco, quae nihil audet per se, nullo adhibetur consilio. Plerique, quum aut *aere* alieno aut magnitudine tributorum aut injuriā potentiorum premuntur, sese in servitutem dicant nobilibus: in hos eadem omnia sunt jura, *quae dominis* in servos.

II.—1. Decline *una* (1), *Sequanis* (1), *deprecatore* (4).

2. Compare *proxime* (7), *multa* (11), *firmo* (18).

3. Write the synopsis, active and passive, of *relinquebatur* (1).

4. State the mood and tense of the following: *impetrarent* (4), *collocarat* (7), *ostendimus* (10–11), *contendit* (19), *egerat* (25).

5. Give the principal parts of the following: *persuadere* (3), *mittunt* (4), *claudebant* (8), *retentorum* (12), *neglecta* (14), *respondit* (21), *colloqui* (23), *velle* (24), *audet* (30), *adhibetur* (30), *premuntur* (32), *dicant* (32).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1882.

1. The Helvetians[1] send[2] embassadors[3] to[4] Dumnorix[5].
2. Embassadors are sent to Dumnorix by the Helvetians.
3. The Helvetians were not[6] able[7] to persuade[8] the Sequani[9].
4. The Helvetians say[10] (that) they are not able to persuade the Sequani.
5. (Re-write sentence fourth in such a manner as to illustrate direct statement.)
6. The Helvetians said: "we are unable to persuade the Sequani."
7. (Re-write sentence sixth in such a manner as to illustrate indirect statement.)

[1] Helvetius. [2] mittĕre. [3] legatus. [4] ad. [5] Dumnorix. [6] non. [7] posse. [8] persuadēre (governs Dative). [9] Sequanus. [10] dicĕre.

LATIN.

SEPTEMBER, 1882.

I.—Translate as literally as possible—

a. Ob eas causas ei *munitioni*, quam fecerat, Titum Labiēnum legatum praefecit; ipse in Italiam magnis *itineribus* contendit duasque ibi legiones conscribit, et tres, quae circum Aquilēiam hiemabant, ex hibernis educit; et qua proximum iter in ulteriorem Galliam per Alpes erat, cum his quinque legionibus ire contendit.

b. Quum se illi identidem in silvas ad suos reciperent ac rursus ex silvā in nostros impetum facerent, neque nostri longius, quam quem ad finem porrecta loca aperta pertinebant, *cedentes* insequi auderent; interim legiones sex, quae primae venerant, *opere* dimenso castra munire coeperunt.

c. Itaque Titum Labiēnum legatum in Trevĭros, qui proximi flumini Rheno sunt, cum equitatu mittit. *Huic* mandat, Remos reliquosque Belgas adeat atque in officio contineat, Germānosque. qui *auxilio* a Belgis arcessiti dicebantur, si per *vim navibus flumen* transire conentur, prohibeat.

d. Ipse cum omnibus copiis in Morinos proficiscitur, quod inde erat brevissimus in Britanniam trajectus. Huc naves undique ex finitimis regionibus et, quam superiore *aestate* ad Venetĭcum bellum *effecerat*, classem jubet convenire.

e. Cicĕro ad haec unum modo respondit: Non esse *consuetudinem* populi Romāni accipere ab hoste armato conditionem: si ab armis discedere velint, *se adjutore* utantur legatosque ad Caesărem mittant: sperare pro ejus justitiā, quae petierint, *impetraturos.*

f. Nam fere de omnibus controversiis publicis privatisque constituunt; et si quod est admissum facinus, si caedes facta, si de haereditate, de finibus controversia est, iidem decernunt; praemia poenasque constituunt. Si qui aut privatus aut populus eorum decreto non stetit, *sacrificiis* interdicunt. Haec poena apud eos est gravissima.

II.—1. Decline *munitioni* (1), *hibernis* (4), *ei* (1).

2. Compare *ulteriorem* (5), *primae* (10), *superiore* (19).

3. Write the synopsis, active and passive, of *conscribit* (3).

4. State the mood and tense of the following: *contendit* (6), *reciperent* (7), *auderent* (10), *conentur* (16), *velint* (23).

5. Give the principal parts of the following: *praefecit*, (2), *contendit* (6), *porrecta* (9), *auderent* (10), *dimenso* (11), *conentur* (16), *jubet* (20), *petierint* (24), *constituunt* (27), *decernunt* (28), *stetit* (30), *interdicunt* (30).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

LATIN EXERCISES.

SEPTEMBER, 1882.

1. Caesar leads-forth[1] three[2] legions[3] from[4] winter-quarters[5].

2. Three legions are led-forth from winter-quarters by Caesar.

3. Caesar said[6] he would lead-forth three legions from winter-quarters.

4. (Re-write sentence third in such a manner as to illustrate *direct* statement.)

. Caesar said: I have led-forth three legions from winter-
rters.
. (Re-write sentence fifth in such a manner as to illustrate
rect statement.)
. Caesar having-hastened[7] into[3] Italy,[9] led forth three legions
n winter-quarters.

ucĕre. [2] tres. [3] legio. [4] ex. [5] hiberna.
cĕre. [7] contendĕre (use pluperf. subjunctive with *Quum*).
. [9] Italia.

HISTORY OF THE UNITED STATES.

JUNE, 1882.

. Give in chronological order the following dates: Settlement
Georgia, Bacon's Rebellion, foundation of St. Augustine, bat-
of Germantown, admission of Kentucky, secession of South
olina.
. Describe the settlement of Rhode Island.
. What changes were made in the French possessions in
erica by the Treaty of Paris?
. When did the first Continental Congress meet, and what
it do?
. What was the Missouri Compromise?
. Who were the presidential candidates in 1860?

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1882.

. Give in chronological order the following dates: Battle of
ttsburg, foundation of Rhode Island Colony, New England
federation, discovery of the Hudson, admission of Missouri.
. Describe the settlement of Georgia.
When and how did the United States acquire Louisiana
Florida?
What were the patroons?
What is the Monroe doctrine?
When and by what States was the Southern Confederacy
ed?

GEOGRAPHY.

JUNE, 1882.

1. Bound the State of Ohio;— name two cities in it and tell how they are situated.

2. Where does the Rio Grande River rise; where does it run and empty; and what States and Territories does it touch?

3. Where is Hindoostan; name two rivers in it and where they rise, which direction they run and where they empty; name two cities in it and how they are situated.

4. Bound Spain; what is its capital; name two chains of mountains in it and tell their situation.

5. Where are the following islands: Cyprus; Ceylon; Teneriffe; Trinidad; and Shetland?

6. How wide is the North Temperate Zone in English miles?

GEOGRAPHY.

SEPTEMBER, 1882.

1. Bound the State of Georgia; give the names of two cities in it; of two rivers in it; and what mountains are in it.

2. Where are the following cities: Buffalo, Denver, Milwaukee, Memphis, Louisville, Atlanta?

3. Give the names of three seaports in South America; tell what country each one is in, and how each is situated.

4. How is the Black Sea bounded; what waters are connected with it; name two rivers that empty into it and tell where they flow from.

5. Bound Morocco and describe its position.

6. Where is Lake Winnipeg; what river runs into it from the United States; what is its outlet and where does it empty?

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EIGHTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1883-84.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
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1884.

STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS

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CHARLES D. HINE

Secretary and Treasurer of the School

GEORGE J. BRUSH

REPORT

OF THE

STATE BOARD OF VISITORS.

o the General Assembly of the State of Connecticut:

The State Board of Visitors, in presenting the Annual eport of the Sheffield Scientific School, take pleasure in ommending its interesting details of the growth and pros- rity of the institution to the special attention of your norable body.

This department of Yale College has been opened a com- ratively short time, but it has already two hundred and irteen students representing twenty-three States and two erritories, and if it continues to receive the financial aid it eserves, it will be able, it is believed, within a few years to apart its advantages to more than double that number. It is gratifying fact that State scholarships in this institution are gerly sought, and that the records of those enjoying these vors are creditable to themselves and the State. The de- ease of the amount of interest paid by Connecticut on money holds, the income of which is devoted to the support of this

school, reduces the number of scholarships to which the State is entitled. It is to be hoped that the deficiency will be met by a special appropriation so that at least thirty of our young men will continue to have the privilege of becoming, without cost of tuition, educated farmers, chemists, engineers or mechanics.

THOMAS M. WALLER,
Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

For the first time in the history of the Sheffield Scientific hool, the Governing Board are under the necessity of recording e death of one of their number while in active service. At the ry beginning of the present Academic year, William A. Norton, e head of the department of Civil Engineering, and the Senior ofessor in the School, died after an illness of four days' duration. the request of the Governing Board, the following sketch of life and work has been prepared by Professor DuBois, who s held to him in turn the relation of pupil and of colleague, and ring the past few years has been on terms of specially intimate endship.

Sketch of Professor Norton's Life.

By the death of Professor Wm. A. Norton, the Sheffield Scientic School loses its oldest and one of its most widely known and loved instructors. A teacher of more than fifty years' experice; an earnest and careful investigator; the School has had most from its very inception—covering a period of more than irty years—the benefit of his skill and zeal. With its growth d development he is identified, and to his faithful and devoted bors its success and reputation are largely due.

William Augustus Norton was born in East Bloomfield, New ork, Oct. 25, 1810, and died Sept. 21, 1883, after an illness of but few days, within a month of the completion of his 73d year. In 327 he entered the *Military* Academy at West Point, where he

graduated with high honors, and in 1831 was promoted Second Lieutenant Fourth Artillery, and assigned to duty as Acting Assistant Professor of Natural Philosophy in the Military Academy. He filled this position until 1833, with the exception of a few months, when he served with his regiment in the "Black Hawk War." In 1833 he resigned his position in the army, and was appointed Professor of Natural Philosophy and Astronomy in the University of the City of New York. This position he filled until 1839. He was afterwards Professor of Mathematics and Natural Philosophy in Delaware College, Newark, Delaware. This post he held for ten years, when he was elected President of the College, and served in this capacity during the year 1850. He then went to Brown University, Providence, Rhode Island, where he had charge of the Departments of Natural Philosophy and Civil Engineering. In 1852 he was elected Professor of Civil Engineering in Yale College, and in the autumn of that year he entered upon his duties with a class of twenty-six students who had followed their instructor from Brown University.

Since then, to the day of his death, he has ever been found at his post of duty, and many of his old pupils now filling responsible positions throughout the length and breadth of our country will testify to the practical value of his instructions, to his great capacity as a teacher, and to his character as a man. A teacher's best testimonial is the esteem and respect of his pupils, his best reward their love and confidence, and in this respect Prof. Norton stood very high. No teacher ever had more loyal students. It has been the privilege of the writer to be once his pupil, afterwards his colleague and always his friend, and during that period of seventeen years, he has never met or known any student to entertain or suffer any doubt of Prof. Norton's entire impartiality, his skill and fidelity as a teacher, or his friendly interest as a man. With a manner peculiarly genial and endearing in the class-room, frank and manly always and sometimes almost jovial—he made every student feel that his instructor was also his personal friend. No student of his ever acted upon this impression and found it to fail. Ever ready with suggestion, advice, and encouragement, always young at heart himself and believing thoroughly in the young men he taught, he was much more to them than the subjects he taught, and his personal influence was better than books. Many of his old pupils will learn of his death with keenest sorrow and will feel his loss as that of a friend.

It is noteworthy that the same year which brought Prof. Norton to us from Brown University, gave us also his colleague in that institution—Prof. John A. Porter—whose early and lamented death at the age of forty-four deprived this department of one of its chiefest and most disinterested and self-sacrificing promoters.

Prof. Norton was not a man whose work began and ended in his class-room, and his scientific and educational contributions were numerous and important. Among these the chief published works are a "Treatise on Astronomy, Spherical and Physical," 1839, and a "First Book of Natural Philosophy and Astronomy," published in 1858. His scientific memoirs were contributed mostly to the *American Journal of Science*, the *Philosophical Magazine* (London), or read at meetings of the American Association for the Advancement of Science, or of the National Academy of Sciences. Of these, the following are some of the more important:

Terrestrial Magnetism.—*American Journal of Science*, second series, vol. iv.

Periodical Variations of the Declination and Directive Force of the Magnetic Needle.—*American Journal of Science*, 1855.

Ericsson's Caloric Engine.—*American Journal of Science*, 1853.

Donati's Comet, two memoirs.—*American Journal of Science*, 1859 and 1861.

Molecular Physics, two memoirs.—*American Journal of Science*, 1864 and 1872.

Principles of Molecular and Cosmical Physics.—*American Journal of Science*, 1870.

The Corona seen in Total Eclipses of the Sun.—*American Journal of Science*, 1870.

Physical Constitution of the Sun.—*American Journal of Science*, 1871.

Dynamical Theories of Heat.—*American Journal of Science*, 1873.

Laws of the Deflection of Beams Exposed to a Transverse Strain, Tested by Experiment.—*Proceedings of American Association*, 1870.

Physical Theory of the Principle of the Lever.—*Proceedings of American Association*, 1870.

Results of Experiments on the Set of Bars of Wood, Iron and Steel, after a Transverse Stress.—Two papers read before the National Academy of Sciences (April, 1874, and April, 1875). A succinct statement of the general conclusions of the two papers published in the *American Journal of Science*, April, 1876.

Results of Experiments on Contact Resistance.—Read before National Academy of Sciences, April, 1876; published in *American Journal of Science*, June, 1876.

The above list sufficiently indicates the scope and character of Prof. Norton's scientific labors. Those of them which pertain to engineering subjects are most valuable contributions to the science of which he was for so long a teacher. His investigation of Ericsson's Caloric Engine was thorough and masterly. Made

at a time when the most extravagant expectations were widely entertained with regard to the new motor, his conclusions, expressed in the paper of 1853, are referred to and quoted to-day as one of the best expositions of the true nature, character and future of the hot air engine.

His experiments upon the Set and Transverse Strength and Deflection of Bars of Wood, Iron and Steel constitute a most important and valuable addition to engineering science. The experiments were conducted with great care and rare skill, and the value of the results has since been repeatedly acknowledged, and the results themselves incorporated into the standard text-books upon the subject. These papers are clear, precise and definite both in statement and description, qualities characteristic of all of Prof. Norton's work, whether in or out of the class-room.

Of his numerous contributions to the *American Journal of Science*, comprising some of the most earnest work of his life, that Journal speaks as follows (Nov., 1883):

"His earliest memoir was in the 46th volume of the first series, and was on the mode of formation of tails of comets. The manner of action of a solar repulsion in producing the comet's tails was developed at length. Some of the ideas, though original with Prof. Norton, had been anticipated by Olbers and Bessel. A series of papers followed upon the relations between the distribution of heat on the earth and the phenomena of terrestrial magnetism.

"From these he was led on to further discussion of magnetic action over the earth, and of like action, as he argued, in the body of the sun, and in the formation of the comas and tails of comets. These papers included especially an elaborate discussion of the famous comet of 1858.

"After this followed a series of papers on molecular physics, in which, starting from a few elementary assumptions, he arranged in one system the various phenomena of physics, explaining the gaseous, liquid and solid forms of matter, the various phenomena of electricity and magnetism, of light, heat, attraction, crystallization and chemical action; also explaining terrestrial, cometary and solar physics, the whole worked out in detail. Many of his conceptions and arguments are in direct opposition to widely accepted theories. But if some, or even if all of them shall, in the end, fail to be accepted as truths of nature, yet these memoirs *will continue* to testify to his love of truth, his painstaking labor *and his* complete grasp of the problems to be solved."

addition to the special purely scientific works above men-
l, Professor Norton was in 1859 appointed engineer on the
of the State of Connecticut to determine the boundary line
troversy between this State and that of New York.

late years Prof. Norton's contributions have been few,
to his almost complete absorption in the preparation of a
which should present in systematic shape the views and
sions above alluded to. Upon this work he based his claim
entific reputation. He spoke of it always with enthusiasm,
ling his views as having passed out of the region of mere
y and as being capable of conclusive demonstration, and he
tly hoped that he might live long enough to complete the

This we believe he did, but his sudden death has pre-
d his superintending its publication. It is to be hoped that
l yet see the light and constitute, as he always hoped it
l, his best claim to scientific reputation.

of. Norton needs, however, no such work as his best claim to
nbrance. That claim is best founded on his daily work as a
ed teacher and on his personal character as a true and high-
ed man.

a teacher the writer can speak from personal experience of
re capacity, and any enthusiasm he might well be betrayed
while on this topic would be heartily endorsed by every one
s former pupils living to-day. And, as with the best
ers, the advantages unconsciously imbibed by his pupils
personal contact; the unconscious influence of high ideals;
e of truth and honor; of personal integrity; of scrupulous
ness—these were lessons daily enforced and more valuable
any of those he so well knew how to extract from the text-
or illustrate on the black-board. His patience and courtesy
unfailing. No student, however trying or dull, ever heard
him an impatient or sarcastic word. With perfect gentle-
a thoroughness which spared no pains, and a clearness of
ition which, in the writer's experience, is very rare, he took
student with him in the prescribed course, and sent him
at graduation, not only a wiser but a better man, and a
nal and enthusiastic friend.

of. Norton was married in 1839 to Miss Elizabeth Emery
ns, of Exeter, N. H., with whom for more than forty years
joyed that household happiness and content for which his
gentle, loving nature so eminently fitted him. Those who

have been admitted to the intimacy of that little household of two know how pleasant it was and how good it was to be there. There, dropping the Professor, his students found always a hearty welcome, and a sympathizing friend, young at heart as themselves—a hearty, cordial and genial comrade.

The record of this long, useful, happy life; the lofty aims and high personal character which lay back of it; the simple faith and sincere convictions which ever guided it; the genial, manly qualities of heart and mind which adorned it; combine to make it one which claims and holds a foremost place in the long list of honored names—faithful teachers, sincere investigators and high-minded men—of which Yale College has a right to be and is most justly proud. The influence of such lives are the best heritage of universities, and their memories are a tower of strength to the institution which claims them, as well as an inspiration and example to the students and colleagues who cherish them.

Gifts.

Mr. Francis A. Livingston, of New York, father of Dr. Beverley Livingston (deceased), who graduated at the S. S. S. in 1874, has sent to the School in accordance with his son's request:

1. A copy of Harvey's *Nereis Boreali-Americana.*

2. A copy of Harvey's Wood's History of the Fresh-water Algæ of North America.

3. Sets of several medical journals for 1880–1883, including the London Lancet, Obstetrical Journal, Progrés Medicale, and many miscellaneous pamphlets on medical subjects; these have been transferred to the College Library.

4. A collection of many hundred microscopic slides, mostly illustrating human histology and pathology. The sections are very carefully prepared, stained and permanently mounted, and form a most valuable collection for the study of healthy and diseased tissues.

5. A collection of Algæ, Musci and other cryptogamous plants made by Dr. Livingston, while a student here, and soon after graduation. The specimens are all well mounted and properly classified and include many duplicates.

The Library of the School has received for the second time a collection of valuable scientific works from Professor Wolcott Gibbs of Harvard University. The list, embracing over a hundred volumes, will be published in the next annual report.

In connection with these gifts it is proper to refer to the loss which the Scientific School, as well as the whole community, has sustained in the death of Henry Farnam, one of the most generous and public-spirited citizens the city of New Haven has ever possessed. To this institution he was a liberal benefactor. In 1868 he made a gift of one thousand dollars. In the Annual Report for 1872, another gift of five thousand dollars is recorded as having been made by a friend of the School who preferred that his name should not be mentioned. The death of Mr. Farnam removes the injunction of secrecy, and it only needs to be said here that he was the person to whom reference was made.

Need of Increased Endowments.

In the number of students the Scientific School continues to show a steady and gratifying advance, and it is not unimportant to add that in excellence of preparation on the part of those desiring to enter, there also continues to be a marked improvement. But it is incumbent on the Governing Board to make known to the graduates and friends of the institution, that additional funds must be provided for its endowment if it is expected to maintain the position it has so long held. It is important to make this announcement because an impression widely prevails that its financial situation is far more favorable than is actually the case. The reduction of the rate of interest by the State of Connecticut from six to five per cent. on the money derived from the sale of the public lands, has reduced the annual income of the School from this source by the amount of thirteen hundred and fifty dollars. On the other hand, the munificent bequest of the generous founder of the School will not be available to its full extent for several years to come. In the meantime its annual income is about five thousand dollars less than during his life. While this diminution may be only temporary in its character, the fact is not to be disguised that unless provision of some kind is made to tide over the interval, it will be necessary, in order to meet current expenses, to encroach to some extent upon the principal of the funds held by the Trustees of the School. There is no need of saying that such action will be taken only as the last resource, but it is action that must inevitably be taken unless the friends of the institution can devise measures to enable the Governing Board to meet the deficit which is now threatened.

States represented in the School.

The following table shows the States from which come the students whose names appear on the catalogue during the current year, and of the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	--	1	4	--	5
2. Colorado	--	2	--	2	--	4
3. Connecticut	6	18	25	28	1	78
4. District of Columbia	--	2	--	2	--	4
5. Georgia	--	1	--	2	--	3
6. Illinois	--	2	3	6	--	11
7. Indiana	--	1	1	--	--	2
8. Iowa	--	1	--	--	--	1
9. Kentucky	--	--	2	1	--	3
10. Maine	--	1	2	1	--	4
11. Michigan	--	--	1	3	--	4
12. Minnesota	--	--	1	3	--	4
13. Missouri	--	1	4	2	--	7
14. Nebraska	--	--	1	2	--	3
15. New Jersey	--	1	2	1	--	4
16. New York	3	9	18	14	1	45
17. Ohio	--	2	3	3	1	9
18. Oregon	--	--	1	--	--	1
19. Pennsylvania	--	4	6	5	--	15
20. Rhode Island	--	--	--	1	--	1
21. Texas	--	--	--	1	--	1
22. Vermont	--	--	--	1	--	1
23. Virginia	--	--	1	--	--	1
24. Washington Territory	--	--	--	1	--	1
25. Wisconsin	--	--	--	1	--	1
Totals	9	45	72	84	3	213

Public Lectures.

The annual course of lectures to mechanics and others has been ven during the past year. The lecturers and their subjects are licated in the annexed programme:

I. Thursday, Feb. 8.—The Luray Caverns as seen by Electric Light. Rev. H. C. Hovey.
II. Tuesday, " 13.—The Transit of Venus. Prof. Newton.
II. Thursday, " 15.—Modern Fiction. Mr. Charles Dudley Warner.
V. Tuesday, " 20.—Photo-Chemistry of the Retina. Prof. Chittenden.
V. Thursday, " 22.—The Trades-Unions of the Middle Ages. Prof. Farnam.
I. Tuesday, " 27.—The History of Connecticut as illustrated in the Names of its Towns. Prof. Dexter.
II. Thursday, Mar. 1.—Domestication of Animals. Prof. Brewer.
II. Tuesday, " 6.—Heat and Work. Prof. DuBois.
X. Thursday, " 8.—Heat and Work. Prof. DuBois.
X. Tuesday, " 13.—The Veda. Prof. Whitney.
I. Thursday, " 15.—Facts illustrative of the Darwinian Theory. Prof. Verrill.
II. Tuesday, " 20.—The Agency of Insects in the Fertilization of Flowers. Dr. E. H. Jenkins.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the S. Engineering School, at Willetts Point, was delivered in rth Sheffield Hall as a part of the instruction in the School ring the second term of the academic year 1882-83. The ler and subjects of the Lectures were as follows:

Monday, Feb. 19.—Strategy and Grand Tactics. Capt. C. W. Raymond, U. S. Engineers.
Friday, " 23.—Logistics. 1st Lieut John Millis, U. S. Engineers.
Monday, " 26.—Small Arms and their influence on Tactics. 1st Lieut. Eugene Griffin, U. S. Engineers.
Friday, Mar. 2.—Artillery. Capt. J. C. Mallery, U. S. Engineers.
Monday, " 5.—Fortification. Capt. J. H. Willard, U. S. Engineers.
Friday, " 9.—Sea Coast Defense. General H. L. Abbott, U. S. Engineers.

Additions to the Department of Dynamical Engineering.

During the past year a number of important additions have been made to the Department of Dynamical Engineering, through the generosity of the business firms and gentlemen named below.

It is believed that the study of these machines and drawings has been and will be of great importance in making the students familiar not only with standard machinery, but particularly as giving practical illustration of how the details of construction are worked out by our most experienced engineers; for the student in the designing of a machine must be guided to a great extent by the unwritten experience of others.

While the usefulness of a machine can not be measured by its money value, when possible the market or list price is noted. For the many beautiful photographs and drawings none of course can be given.

F. R. Pickering & Co., Portland, Ct. A "1½ in" Pickering Governor, finely finished with side cut away to show the construction and operation of valve. $31.50.

The Perpetual Tension Belt Co., New York. Samples of flexible wire belting.

The Yale Lock Manufacturing Co., Stamford, Ct. A one-ton Weston Differential Pulley Block with weight, a standard machine. $30.00.

W. & B. Douglas, Middletown, Ct. A "No. 2" brass Hydraulic Ram with glass air chamber to show operation of valves. $20.00.

The Tanite Co., Stroudsburg, Pa. A "No. 3" Emery Grinding Machine, complete with counter-shaft, cone pulley and hangers; together with a set of nine 18-in. emery wheels of various grades and shapes. $239.00.

The Crosby Steam Valve and Gauge Co., Boston. A fine "Crosby" Indicator, nickel plated and complete in every respect. $90.00.

The American Steam Gauge Co., Boston. A fine "Thompson" Improved Indicator," nickel plated and complete in every respect. Also an "Amsler Polar Planimeter" for measuring the area of indicator cards and a pantograph for reducing the motion of engine; in all $130.00. Also from the same firm, two nickel plated *Bourdon* Spring Gauges, one steam, the other vacuum, and two

ickel plated Lane's Improved Spring Gauges, with a portion of ıce cut away to show interior construction; in all $62.00.

The Deane Steam Pump Co., Holyoke, Mass. A beautifully nished "No. 3" Deane Steam Pump, with portions cut away to ıow the details of construction and arrangement of valves. 225.00.

Ed. Dewey & Co., Boston. A "2-in." Waters Engine Gover-or, with automatic safety-stqp attachment. $32.00.

Hancock Inspirator Co., Boston. Two inspirators or injectors nely mounted, one in section showing the construction and peration of valves, the other complete. $40.00.

The Knowles Steam Pump Works, New York. A "No. 1" team Pump beautifully finished and complete in every respect. 125.00.

Foskett & Bishop, New Haven. A very complete set of Steam ipe Fittings, with sections of pipe, numbering in all 116 pieces. 40.00.

The Eaton, Cole & Burnham Co., Bridgeport. Sets of nickel lated Globe Valves, Check Valves, Angle Valves, and Plug 'ocks, including all sizes up to 2-in. diameter. These valves were xhibited by the Company at the Centennial Exposition in 1876, nd are finely finished. $103.00.

Reynolds & Co., New Haven. A complete set of Bolts, Nuts, Machine and Lag Screws, up to $\frac{3}{4}$ in. diameter. $15.00.

Mr. Henry Tyler, New Haven. Small Steam Whistle.

McLagon & Farnsworth, New Haven. Samples of Pig Iron nd Moulding Sand.

Henry R. Worthington & Co., New York. In addition to the eam Pump already acknowledged, a fine water meter, and ree large framed photographs of pumping machinery.

Colt's Patent Fire Arms Manufacturing Co., Hartford. A set Baxter Engine Piston Springs.

Messrs. Schutte & Goehring, Philadelphia. A "No. 3" Ex-ust Steam induction Condenser, beautifully finished and mounted exhibition. $80.00.

Mr. Frank Bigelow, New Haven. A Four Horse Power verti-l Steam Engine, well proportioned and complete in every spect. $150.00.

Naylor & Co., Boston, through Messrs. Ensign & Son of ew Haven. A fine case of Compressed Steel Shafting.

The Deane Steam Pump Co., Holyoke, Mass. A set of twelve large framed photographs of Pumping Machinery.

The Bureau of Steam Engineering, Washington. A set of drawings of Launch Engines and Boilers built in the Government Yards; also large lithographs of Compound Engines designed for Monitors.

The Pratt & Whitney Co., Hartford. Drawings of Bench Drilling Machine.

Wm. A. Harris, Providence, R. I. Large framed photograph of Corliss Engine.

The Providence Steam Engine Co., Providence. Large framed photograph of the Improved Green Engine.

Wm. Contie & Son, Troy, N. Y. Two large framed photographs of Compound Engines.

Willimantic Linen Co., Willimantic, Ct. Large framed photograph of Porter Allen Engines, and also lithograph of their new Mill.

Wm. Clark & Co., Pittsfield, Mass. Large framed photographs of Rotary Pumps.

The Silsby Manufacturing Co., Seneca Falls, N. Y. Framed photograph of Silsby Steam Fire Engine.

The Babcox & Wilcox Co., New York. Framed lithograph of Root Boilers.

Davidson Steam Pump Co., Brooklyn. Large framed photograph of Compound Condensing Pumping Engine.

The Portland Co., Portland, Me. Large photographs of Marine Engine and Fishing Steamer.

E. P. Allis & Co., Milwaukee, Wis. Large photograph of Compound Pumping Engine.

Watts, Campbell & Co., Newark, N. J. Large framed photograph of Corliss Engine.

In addition to the above a large number of valuable trade circulars and book catalogues have been received, which as soon as practicable will be placed on file and indexed.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

The exploration of the sea-bottom beneath the Gulf Stream, off ıe southern coast of New England, which the U. S. Fish Com-ıission undertook in 1880, was continued during the summer acation, by means of the new steamer Albatross, Lieut. Z. L. anner commanding. The headquarters were at Wood's Holl, lass., as in 1881 and 1882. The curator, as heretofore, had gen-ral charge of the invertebrata, and the party of naturalists was rganized nearly as in the previous years. The collections ob-ıined last year were quite as large and even more valuable than ı the three previous seasons. The invertebrata, as usual, were ent to our museum for determination and distribution. When ıis is done, series are deposited in the Museum. During the resent year, large numbers of those that have been worked up ave been labeled and sent to the National Museum, at Washing-on.

The curator has published during the year, in the Bulletin of ıe Museum of Comparative Zoology, a report on the deep-water nthozoa taken off our coast and in the West Indies by Mr. A. gassiz, on the Blake, and by the Fish Commission, illustrated y eight plates; and others on the deep-sea Cephalopods dredged y the Blake in the West Indies, and on the Pacific coast Cepha-pods, illustrated by several plates.

Professor S. I. Smith has taken charge of the Crustacea in the luseum. He has published in the Proceedings of the Na-onal Museum a lengthy illustrated paper on the deep-water rustacea taken by the Fish Hawk, in 1880 to 1882; and others n the Crustacea of Labrador.

Mr. J. H. Emerton, besides making most of the drawings for ıe reports named above, as well as for others in progress, has epared for publication in the Trans. Conn. Academy, vol. vi, a onograph of the New England Spiders of the family Epeiridæ, lustrated by eight plates.

Mr. Emerton has also finished the life-sized restoration of one the gigantic Cephalopods of Newfoundland (*Architeuthis prin-ps*), now on exhibition in the Museum. He has, also, completed vo duplicates of this: one for the Museum of Comparative oology, and one for the National Museum, and has made a

large model of the great California Octopus (*O. punctatus*), for the National Museum. The latter and one of the models of *Architeuthis* were sent to the Fishery Exhibit, in London. Mr. Emerton is now making two additional copies of the Octopus model: one for our Museum, and one for the Museum of Comparative Zoology. In the making of these models he has been assisted by Mr. William Palmer, of Washington, Mr. A. Baldwin, and others. A cast of the Gulf Stream dolphin (*Delphinus delphis*) has also been finished and put on exhibition by Mr. Emerton.

Miss K. J. Bush has been engaged in labeling and cataloguing the large collections of shells made by the U. S. Fish Commission during the past twelve years, and in other similar work. She has also prepared a report on the shells and Echinoderms of Labrador, illustrated by a plate drawn by Mr. Emerton. This has been printed in the Proceedings of the National Museum.

Mr. Oscar Harger has published in the Bulletin of the Museum of Comparative Zoology, a report on the Isopods of the Blake Expeditions, illustrated by several plates.

The collection of fishes obtained by the late Professor F. H. Bradley, at Panama and other localities on the west coast of America, has been worked up by Messrs. D. F. Jordan and C. H. Gilbert, who have published a catalogue of them in the Proceedings of the National Museum. The fishes of the Gulf of Mexico and S. America, have also been sent to Mr. Gilbert.

In addition to the large collections from the U. S. Fish Commission, the following have been received:

Milton W. Jacobs. Squilla, New Haven; Green Callosoma.

T. S. Gold. Pomotis, from Naugatuck River; lice of cattle.

National Museum. A new species of Octopus (*O. bimaculatus V.*) from San Diego, Cal.; shrimp from New Orleans.

Horace Bowman. Eel-pout (*Zoarces*) from Long Island Sound.

Prof. D. C. Eaton. Three species of land shells from Cuba, coll. Dr. A. P. Garber.

C. F. Graves. Parasitic crustacean.

J. A. Allen (S. S. S.). Fresh-water shells from Nova Scotia.

E. H. Hubbard, Woodmont. Actinia.

W. B. H. Trowbridge. Several eels, (*Ophisurus*) and a fine *Pentacrinus*, in alcohol, from Barbados.

Chas. E. Bowles. Puffing adders, East Rock.

M. Schultheiss. Wasp nest, New Haven.

T. Bary. Egg of snake, New Haven.

Henry A. Barnes, New Haven. Nest of Maranta Bee.

Museum of Comparative Zoology. A valuable series of deep-ea Ophiurans and Echini, from the Blake Expeditions. Also a eries of duplicates of the Blake Crustacea.

By purchase. Four young foxes with their mother. From North Branford.

Two seals (*Phoca vitulina*) taken at Guilford in April.

A large *Octopus vulgaris* from Hamilton Inlet, Bermuda. Said to have crawled upon the deck of the yacht Peerless.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 28, 1883. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. Those marked with an asterisk read theses in the evening.

Bachelors of Philosophy. (45).

John Alpheus Allen (Chemistry), *New Haven.* On the Phosphates of Manganese produced by reactions of Fused Compounds.

John Bartholomew (Dynamic Engineering), *Guilford.* On the Development of Electrical Science.

Frederick Elijah Beach (Dynamic Engineering), *New Haven.* On the Storage of Electrical Energy.

*Charles Milo Carpenter (Civil Engineering), *Madison, Wisc.* On the Lamberton Street Iron Bridge over the N. Y., N. H. & H. R. R.

Samuel Myron Chase (Select), *Chicago, Ill.* On the Archæan and Paleozoic Time.

*Edward Bradford Dench (Biology), *Bridgeport.* On the Anatomy and Histology of the Ear.

Edward Peers Eastwick, Jr. (Dynamic Engineering), *New York City.* On the Transmission of Power to Great Distances.

Horatio Southworth Frazer (Chemistry), *Holyoke, Mass.* On the Bleaching Processes used in Paper Manufacture.

James Lyman (Dynamic Engineering), *Middlefield.* On the Strength of Iron and Steel with reference to Bridge Construction.

Henry Curtis Nutt, Jr. (Civil Engineering), *Boston, Mass.* On the Construction of Suspension Bridges.

Charles Locke Scudder, B.A. (Biology), *Great Barrington, Mass.* On the Origin and Nature of the Proteolytic Ferment of the Gastric Glands of the Rabbit.

Robert Hawthorne Wylie (Biology), *Chester, S. C.* On the Germ Theory of Disease.

PAUL WHITIN ABBOTT (Select), *New Haven.* On the Policy of Gladstone in regard to Ireland.

BENJAMIN SAFFORD BARROWS (Biology), *Hartford.* On the Development of the Vertebral Column of the Chick.

GEORGE ANDREW BARROWS (Select), *Philadelphia, Pa.* On the Treatment of the Supernatural by Bulwer in his Novels.

FREDERICK ROBINSON BARTLETT (Chemistry), *Freeport, Ill.* On the Methods of Determining Silicon in Pig Iron.

FREDERICK TRUMAN BRADLEY (Chemistry), *New Haven.* On Commercial Fertilizers, their Use and Manufacture.

CHARLES SUMNER BROWN (Dynamic Engineering), *Easthampton.* On the Development of Bolt and Screw Cutting Machinery.

HORACE RAYMOND CARPENTER (Civil Engineering), *Afton, N. Y.* On Derrick Cranes.

HARRY NELSON COVELL (Dynamic Engineering), *Stamford.* On the Holly System of Steam Heating.

WAYNE DARLINGTON (Dynamic Engineering), *Westchester, Pa.* On Light Iron Bridges.

HENRY KELSEY DEVEREUX (Select), *Cleveland, O.* On the United States Life Saving Service.

ROBERT OGDEN DUBOIS (Biology), *New Haven.* On the Histology of the Tea Leaf and the Detection of its Adulterations by the Microscope.

CHARLES LOCKWOOD GOLD (Agriculture), *West Cornwall.* On the Preparation of Maple Sugar.

CHARLES STEWART HALL (Civil Engineering), *Warren, O.* On the Construction of the Foundations of the Piers of the St. Louis and Illinois Bridge.

GEORGE VANCE HARPER (Dynamic Engineering), *Denver, Col.* On Structures of Iron and Steel.

WILLIAM HARPER (Select), *Shippensburg, Pa.* On the Postal Savings Bank System.

ALLEN HUBBARD (Dynamic Engineering), *Westfield, Mass.* On the Engine Lathe.

JOHN ELMER LOCKWOOD (Select), *Stamford.* On the Early History of the English Tongue.

WILLIAM ELLISON LOCKWOOD (Biology), *Stamford.* On the Anatomy and Histology of the Mammalian Eye.

JOHN HENRY MANN (Dynamic Engineering), *Utica, N. Y.* Design for a Vertical Engine with Special Valve Gear for Reversing.

JOHN EDMUND NEWELL (Chemistry), *Chicago, Ill.* On the Methods of Determining Manganese in Iron and Steel.

GEORGE SHIPMAN PAYSON (Dynamic Engineering), *Chicago, Ill.* On the Manufacture of Iron.

EDWARD WELLS PENFIELD (Dynamic Engineering), *Chicago, Ill.* On Steel.

DAVID MURDOCH PRATT (Select), *Elmira, N. Y.* On the National Banking System.

WILLIE SHERMAN RANDALL (Biology), *Birmingham.* On the Anatomy and Histology of the Kidney of the Cat.

ALBERT WILLIAM ROBERT (Chemistry), *New York City.* On Pararzoxybenzanilide.

CHARLES LANSING SAYRE (Chemistry), *Utica, N. Y.* On the Electrolytic Depositions of Antimony and other Metals.

HORACE LEE SIMPSON (Biology). *Pensacola, Fla.* On the Anatomy and Histology of the Eye of the Common Fowl.

EBENEZER HUBBARD SKINNER (Select), *Escambia, Fla.* On the Protection of the Iron Industries of the United States.

OSEPH ALLEN SKINNER (Dynamic Engineering), *Holyoke, Mass.* On the Power Loom.

DWARD IRVING STONE (Select), *Bethlehem.* A Geological Review of the Age of Man.

OHN EDWARDS STRYKER (Dynamic Engineering), *Catskill, N. Y.* On the Theory of Draught in Chimneys.

HUAN LOK WING (Civil Engineering), *Canton, China.* On the Musconeteong Tunnel.

LEXANDER WURTS (Dynamic Engineering), *New Haven.* On the Conservation of Energy.

PRIZES.

At the Anniversary Exercises on June 28th the following prizes were announced:

CLASS OF 1883.

For excellence in Civil Engineering, HENRY C. NUTT, Jr.

For excellence in Dynamic Engineering, JOHN BARTHOLOMEW, and FREDERICK E. BEACH.

For excellence in German, JOHN BARTHOLOMEW.

CLASS OF 1884.

For excellence in the Mathematics of Junior Year, CHARLES P. FARQUHAR; with honorable mention of EDWIN M. HERR, and WILLIAM W. NICHOLS.

CLASS OF 1885.

For excellence in all the Studies of Freshman Year, JOHN V. HANNA; with honorable mention of CHARLES D. MCCANDLISS.

For excellence in German, LOUIS M. SCHMIDT.

For excellence in Mathematics, JOHN V. HANNA.

For excellence in Physics, JOHN V. HANNA.

For excellence in Chemistry, JAMES J. MORGAN.

For excellence in Mechanical Drawing, JOHN J. FLATHER, and SYDNEY A. REEVE.

For excellence in English Composition—1st Prizes, GRENVILLE F. ALLEN, CHARLES D. MCCANDLISS; 2d Prizes, ROBERT N. BRACE, WALLACE S. CLARK, JOHN E. HILL, LOUIS M. SCHMIDT; 3d Prizes, MERRITT M. CLARK, JOHN J. FLATHER, IRVING C. GLADWIN, JOHN V. HANNA.

PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1883-84.

CALENDAR.

1883.		
13 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.
1884.		**Winter Vacation of three w**
10 Jan.	Thursday,	Second Term begins.
9 April,	Wednesday,	Spring Recess begins.
16 April,	Wednesday,	Spring Recess ends.
24 June,	Tuesday,	Meeting of Appointing Board.
24 June,	Tuesday,	Anniversary.
25 June,	Wednesday,	Commencement.
26, 27, 28 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of twelve w
16, 17 Sept.	Tues., Wedn.,	Examination for Admission.
18 Sept.	Thursday,	First Term begins.
18 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in Nort field Hall.

CORPORATION.

PRESIDENT

REV. NOAH PORTER, D.D., LL.D.

FELLOWS

IS EXCELLENCY THOMAS M. WALLER, M.A., NEW LONDON
IS HONOR GEORGE G. SUMNER, HARTFORD
EV. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN
EV. GEORGE J. TILLOTSON, M.A., WETHERSFIELD
EV. AMOS S. CHESEBROUGH, M.A., DURHAM
EV. MYRON N. MORRIS, M.A., WEST HARTFORD
ON. WILLIAM M. EVARTS, LL.D., NEW YORK CITY
IIEF JUSTICE MORRISON R. WAITE, LL.D., WASHINGTON, D.C.
EV. LAVALETTE PERRIN, D.D., TORRINGTON
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FRANKLIN B. DEXTER, M.A.

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Y C. KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

AH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

———,
Engineering.

R S. LYMAN,
and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

M D. WHITNEY,
istics and French. (205 D.) 227 Church st.

J. BRUSH,
alogy. (3 S. H.) 14 Trumbull st.

W. JOHNSON,
etical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

M H. BREWER,
ulture (NORTON *Professor.*) (4 S. H.) 246 Orange st.

CLARK,
matics. (40 N. S. H.) 30 Trumbull st.

C. EATON,
y. (41 N. S. H.) 70 Sachem st.

S R. LOUNSBURY,
sh. 22 Lincoln st.

D. ALLEN,
tical Chemistry and Metallurgy. (1 S. H.) 197 Temple st.

N E. VERRILL,
y and Geology. (15 P. M.) 86 Whalley av.

I. SMITH,
rative Anatomy. (14 P. M.) 78 Whalley av.

M G. MIXTER,
istry. (8 S. H.) 8 Trumbull st.

DUBOIS,
mical Engineering (HIGGIN *Professor.*) (45 N. S. H.) 258 Bradley st.

W. FARNAM,
cal Economy and History. 43 Hillhouse av.

L H. CHITTENDEN,
ological Chemistry. (12 S. H.) 32 Trumbull st.

LECTURERS, INSTRUCTORS AND ASSISTANTS.

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. Tremont House.

MARK BAILEY,
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JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

THOMAS W. MATHER,
Kinematics and Machine Design. (45 N. S. H.) 19 Warren pl.

ALLEN B. HOWE,
Analytical Chemistry. 138 College st.

CHARLES HILDEBRAND,
Mathematics. 747 State st.

SAMUEL L. PENFIELD,
Mineralogy. (2 P. M.) 14 S. H.

WILLIAM H. TREADWELL, JR.,
French. 12 Whalley av.

SAMUEL E. BARNEY,
Civil Engineering. 609 State st.

ALTON W. LEIGHTON,
Drawing. 129 College st.

HAROLD B. NYE,
Analytical Chemistry. 91 W.

LOUIS V. PIRSSON,
Analytical Chemistry. 53 Prospect st.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

GRADUATE STUDENTS

ırtholomew, PH.B.	*Guilford*	91 Olive st.
Guyot Dana, B.A.	*New Haven*	24 Hillhouse av.
Heber Graves, B.A.	*New Haven*	61 Grove st.
Wolcott Lyman, B.A.	*New Haven*	88 Trumbull st.
; Burr Osborne, B.A.	*New Haven*	156 Crown st.
'alentine Pirsson, PH.B.	*New York City*	4 Mansfield st.
Lucius Penfield, PH.B.	*Catskill, N. Y.*	14 S. M.
Eugene Smith, PH.B., Univ. of Pa.	*New Haven*	76 Howe st.
n Eldred Worcester, A.B.	*New York City,*	72 W. D.

SENIOR CLASS

Gustavo Alfonso	*New York City*	36 Elm st.
Elwood Harvey Allcutt	*Kansas City, Mo.*	101 W.
Laurence Vincent Benét	*Washington, D. C.*	18 Trumbull st.
Edward Blake	*New Haven*	107 W.
Clarence Russell Britton	*Cleveland, O.*	36 Elm st.
Chauncey Rea Burr	*Portland, Me.*	119 W.
Albert Park Campbell	*New Haven*	28 York sq.
Herbert DeWitt Carrington	*New Haven*	527 Chapel st.
William Brainard Coit	*New London*	36 Elm st.
Clifford Laurence Colton	*Canton*	65 Grove st.
Louis Edward Cooper	*Ansonia*	94 York sq.
George Wyckoff Cummins	*Vienna, N. Y.*	94 York sq.
Charles Percival Farquhar	*York, Pa.*	289 York st.
Arthur Bixby Ferguson	*New Haven*	30 Crown st.
Davenport Galbraith	*Erie, Pa.*	36 Elm st.
Morgan Augustus Guinnip	*Washington, D. C.*	116 Crown st.
Calvin Linsley Harrison	*New Haven*	94 Wooster st.
John Bell Hatcher	*Cooper, Iowa*	12 Elm st.
Samuel Brown Hawley	*Yonkers, N. Y.*	43 College st.
Edwin Musser Herr	*Denver, Col.*	289 York st.
James Henry Jennings	*Redding*	17 College st.
Henry Clay Johnson	*Rome, Ga.*	201 Chapel st.
Thomas Crossley Johnson	*New Haven*	80 LaFayette st.
Edson Keith, Jr.	*Chicago, Ill.*	36 Elm st.
Duane Judson Kelsey	*Killingworth*	266 York st.
Albert Lucas	*Philadelphia, Pa.*	43 College st.
James Minor Maghee	*Evansville, Ind.*	65 York sq.
Luther James Martin	*Norwich*	361 Elm st.
Seyton Howard Martin	*Clifton, N. Y.*	71 W.
George Edgar Moulthrop	*New Haven*	253 North Front st.
William Wallace Nichols	*Manitou Springs, Col.*	289 York st.
Albert Anderson Noye	*Buffalo, N. Y.*	99 Wall st.
Herbert Lincoln Noyes	*New Haven*	74 High st.
Joseph Powell, Jr.	*Towanda, Pa.*	43 College st.
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	73 Mansfield st.
Walter Allen Sadd	*South Windsor*	159 Temple st.
William Godfrey Sage	*Chicago, Ill.*	65 York sq.
Russell Sargent	*New Haven*	51 Elm st.
Clarence Wellington Sheldon	*Brooklyn, N. Y.*	36 Elm st.
William Tuttle Shepard	*Bristol*	17 College st.
John Prentice Terry	*Brooklyn, N. Y.*	121 Park st.
Chester Thorne	*Millbrook, N. Y.*	101 W.
James Henry Warner	*Steubenville, O.*	63 Prospect st.
Elmore Abram Willets	*Belmont, N. Y.*	43 College st.
Andrew Lincoln Winton	*Bridgeport*	63 Prospect st.

JUNIOR CLASS

Arthur Bronson Adams	*New Haven*	120 St. John st.
Grenville French Allen	*New Haven*	197 Temple st.
Philip VanWyck Anderson	*Sing Sing, N. Y.*	68 w.
James Arthur Atwood	*Wauregan*	43 College st.
John Frank Babcock	*Elmira, N. Y.*	36 Elm st.
Paul Daily Bernard	*Brooklyn, N. Y.*	68 w.
Clarence Blakeslee	*New Haven*	316 George st.
Robert Neill Brace	*Dobbs Ferry, N. Y.*	57 w.
Fred Spencer Bullene	*Kansas City, Mo.*	36 Elm st.
Richard Morton Bushnell, Jr.	*Saybrook*	225 Orange st.
Merritt Mead Clark	*Bedford, N. Y.*	177 Temple st.
Wallace Sherman Clark	*New York City*	226 George st.
Arthur Chandler Coates	*Kansas City, Mo.*	36 Elm st.
Arthur Carrington Cowles	*Wallingford*	136 College st.
William Ledlie Culbert	*Brooklyn, N. Y.*	57 w.
John Joseph Flather	*Bridgeport*	295 York st.
William Holt Gale	*New York City*	324 Prospect st.
Irving Cook Gladwin	*Sherburne, N. Y.*	59 w.
Jacob Phillip Goodhart	*New Haven*	107 Court st.
Charles Lord Griffith	*San Francisco, Cal.*	36 Elm st.
John Venable Hanna	*Kansas City, Mo.*	58 w.
John Ethan Hill	*Mystic Bridge*	314 York st.
David Leavitt Hough	*Fort Wayne, Ind.*	59 w.
Percy Jackson	*Belleville, N. J.*	203 York st.
Edwin Young Judd	*Hartford*	86 w.
Amos William Kimball	*Portland, Oregon*	43 College st.
Harry D. Kohn	*Chicago, Ill.*	63 w.
Ira Lamb	*Franklin*	157 Orange st.
Percy Lyford Lang	*Waverly, N. Y.*	43 Chapel st.
Charles Pond McAvoy	*Chicago, Ill.*	43 College st.
Charles Dickerman McCandliss	*Philadelphia, Pa.*	58 w.
William Adair McDowell	*Lexington, Ky.*	43 College st.
Daniel William Maher	*New Haven*	129 Spring st.
Daniel Delevan Mangam, Jr.	*Sing Sing, N. Y.*	43 College st.
William Edward Martin	*Allentown, Pa.*	167 Temple st.
Edwin Alexander Meredith	*Xenia, O.*	65 York sq.
Deane Miller	*New Rochelle, N. Y.*	226 George st.
Herbert Lincoln Mitchell	*New Haven*	52 Insurance B'ld'g.
James Jacob Morgan	*New Haven*	470 Elm st.
William Alpheus Nettleton	*Kansas City, Mo.*	124 w.
Truman Handy Newberry	*Detroit, Mich.*	43 College st.
Isaac Norris, 3d	*Philadelphia, Pa.*	77 w.
George Washington Norton, Jr.	*Louisville, Ky.*	124 w.
Henry Oliver	*Pittsburgh, Pa.*	106 w.
John Cunningham Oliver	*Pittsburgh, Pa.*	106 w.
Abbott Chandler Page	*Fair Haven*	South Quinnipiac st.
Willis *LaFayette Perkins*	*Portland, Me.*	203 York st.

Royal Watson Pinney	*Derby*	167 Temple st.
Daniel Tuthill Pratt	*Elmira, N. Y.*	36 Elm st.
Sidney Armour Reeve	*Dayton, O.*	59 Grove st.
Willard Crawford Reid	*Lakeville*	74 High st.
John Rice	*Pottstown, Pa.*	43 College st.
Charles Thomas Richardson	*Hornellsville, N. Y.*	43 College st.
William Todd Ross	*Belfast, Me.*	60 W.
Charles Gideon Rupert	*New Market, Va.*	111 Dwight st.
Frank Elbert Sands	*New Haven*	119 Dwight st.
Louis Milton Schmidt	*New Britain*	59 Grove st.
James Alward Seymour	*Auburn, N. Y.*	36 Elm st.
Murray Shipley, Jr.	*Cincinnati, O.*	109 Elm st.
Joseph Godfrey Snydacker	*Chicago, Ill.*	63 W.
Frank Jerome Stevens	*New Haven*	7 Wooster pl.
William VanSchoonhoven Thorne	*New York City*	133 College st.
Henry Lee Townsend	*New York City*	88 W.
Curtiss Chauncey Turner	*Omaha, Nebr.*	60 W.
George Elliot Verrill	*New Haven*	86 Whalley av.
Frederick Brewster Wheeler	*Monroe*	175 Temple st.
Henry Howard Whitehouse	*Hartford*	167 Temple st.
Willis Stoughton Williams	*Minneapolis, Minn.*	65 York sq.
Winslow Tracy Williams	*Norwich*	71 W.
Edward Simpson Wilson	*New York City*	119 W.
Clarence Henry Wood	*Morristown, N. J.*	43 College st.
Benjamin Elizur Wright	*Cromwell*	91 W.

JUNIORS, 72

FRESHMAN CLASS

William Allender	*New London*	134 College st.
Gilbert Lincoln Husted Arnold	*Stamford*	607 Elm st.
William Wallace Atterbury	*Detroit, Mich.*	55 Prospect st.
Nathan Edward Ayer	*Bangor, Me.*	Church st.
Silas Warren Bartlett	*New Haven*	675 Chapel st.
Emil Baumgarten	*New York City*	63 Prospect st.
Henry William Blake	*New Haven*	149 Temple st.
John Marvin Blakeley	*St. Paul, Minn.*	251 Church st.
Howard Cone Bolton	*Cleveland, O.*	55 W.
Percival Ranney Bolton	*Cleveland, O.*	55 W.
Louis Whitford Bond	*New York City*	61 W.
Thomas Stoddard Bronson	*New Haven*	684 Chapel st.
Harry Lockwood Burns	*Milford*	57 Prospect st.
Lewis Emerson Cadwell	*New Haven*	106 Liberty st.
Fred. Eaton Case	*Detroit, Mich.*	76 Mansfield st.
Theodore Newton Case	*Hartford*	87 Trumbull st.
John Chamberlain	*Kansas City, Mo.*	76 Mansfield st.
Lucian Thorp Chapman	*New York City*	156 Grove st.
George Frederick Converse	*New Haven*	158 Olive st.
Frederick William Darlington	*West Chester, Pa.*	105 Wall st.
Alexander Harrison Davis	*Watertown*	104 Wall st.
John Edwin Doane	*Chicago, Ill.*	92 W.
Joseph Osterman Dyer, Jr.	*Galveston, Texas*	31 Trumbull st.
Ansel Mills Easton	*Millbrae, Cal.*	215 York st.
Charles Francis Emerson	*Titusville, Pa.*	38 Elm st.
Harvey Farrington	*Croton, N. Y.*	64 High st.
Joseph Essex Fitzsimons	*Waterbury*	84 Dixwell av.
Robert Elder Forster	*Harrisburg, Pa.*	44 Elm st.
Charles Albert Fry	*Westville*	147 Bradley st.
Frederick Abbot Goodwin	*Rutland, Vt.*	82 Wall st.
William Washington Gordon, 3d	*Savannah, Ga.*	115 Elm st.
James Eugene Greenebaum	*Chicago, Ill.*	110 Olive st.
Everett Mason Grimes	*Oakland, Cal.*	161 Temple st.
Theodore Newell Haller	*Seattle, Wash. Terr.*	76 Mansfield st.
Harry Cloyd Hamill	*Georgetown, Col.*	161 Temple st.
David Neil Harper	*Shippensburgh, Pa.*	287 York st.
Frank Sperry Harrison	*New Haven*	18 Warren st.
Willis Benjamin Herr	*Denver, Col.*	287 York st.
Jay Russell Hickox	*South Britain*	270 Martin st.
William Brisbane Hickox	*Litchfield*	128 High st.
William Barlow Hill	*Greenfield Hill*	17 College st.
Abraham Lincoln Howes	*Black Rock*	63 Prospect st.
Marvin D. Hubbell	*New York City*	94 York sq.
William Evelyn Hutchings	*Louisville, Ky.*	163 Temple st.
Morison Thomas Hutchinson	*Brooklyn, N. Y.*	165 Temple st.
Abraham Lincoln Hyde	*New Haven*	179 Washington st.

William David Johnson	*New Haven*	92 Rosette st.
Henry Bourne Joy	*Detroit, Mich.*	72 High st.
Thomas Coggeshall Knowles	*San Francisco, Cal.*	161 Temple st.
Harrie Sheldon Leonard	*Washington, D. C.*	8 Lock st.
Cornelius Fay Lynde	*Rock Island, Ill.*	237 Orange st.
Mahlon Henry Marlin	*New Haven*	178 George st.
Frederick Anderson Marsh	*Kansas City, Mo.*	109 Wall st.
Conrad Henry Matthiessen	*Cornwall, N. Y.*	155 Elm st.
Arthur Meeker	*Chicago, Ill.*	124 High st.
Edwin Frank Meyer	*Chicago, Ill.*	110 Olive st.
George Perkins Miller	*Utica, N. Y.*	163 Temple st.
Samuel Everett Oakes	*Washington, D. C.*	184 York st.
Henry White Patten	*North Haven*	17 Wooster pl.
George Eustis Potts	*Philadelphia, Pa.*	61 W.
James Frederick Prentiss	*Watertown, Wisc.*	44 Elm st.
William Acker Rice	*St. Paul, Minn.*	251 Church st.
Arthur Jones Richmond	*Providence, R. I.*	55 Trumbull st.
Samuel Bostwick Robbins	*Lakeville*	87 Trumbull st.
Reginald Ronalds	*New York City*	134 College st.
Alexander Holley Rudd	*Lakeville*	61 Grove st.
Henry Rustin	*Omaha, Nebr.*	New Haven House
Emanuel Frank Selz	*Chicago, Ill.*	110 Olive st.
Edwin Coupland Shaw	*Buffalo, N. Y.*	63 Prospect st.
Alfred Edgar Siviter	*West Stratford*	91 W.
Edward Arthur Smith	*Middletown*	61 Prospect st.
George Howard Smith	*Canajoharie, N. Y.*	167 Temple st.
William Sanders Tevis	*San Francisco, Cal.*	44 Elm st.
John Metcalfe Thomas	*New York City*	134 College st.
Louis Denio Tourtellot	*Utica, N. Y.*	124 High st.
Calvert Townley	*Cincinnati, O.*	192 York st.
George Pollok Devereux Townsend	*Middletown*	252 York st.
Thomas Brodhead VanBuren, Jr.	*Englewood, N. J.*	55 Trumbull st.
Henry Hayes Wadsworth	*Glencoe, Minn.*	Allingtown
James Edward Warnock	*Atlanta, Ga.*	128 York st.
John Willard Willard	*New York City*	109 Elm st.
Charles Willcox	*Omaha, Nebr.*	163 Temple st.
Rockwell Amasa Williams	*Canterbury*	104 Wall st.
Robert McKnight Woods	*New Haven*	210 George st.

FRESHMEN, 84

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Ross Alberger	*Buffalo, N. Y.*	292 Ferry st.
Francis Lewis Sperry	*Tallmadge, O.*	146 College st.
James Prior Wood	*West Haven*	2 Church st.

SPECIAL STUDENTS, 3

SUMMARY.

GRADUATES,	9
SENIORS,	45
JUNIORS,	72
FRESHMEN,	84
SPECIAL,	3
TOTAL,	213

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction
l researches in the mathematical, physical, and natural sciences,
:h reference to the promotion and diffusion of science, and also
the preparation of young men for such pursuits as require
»ecial proficiency in these departments of learning. It is one of
: Departments of Yale College, like the law, medical, theologi-
, and art schools, having its separate funds, buildings, teachers,
l regulations, but governed by the Corporation of Yale Col-
;e, which appoints the professors and confers the degrees. It
in part, analogous to the academic department, or classical col-
;e, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons
alified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical
d scientific, in less part linguistic and literary, for higher scien-
e studies, or for various other occupations to which such
ining is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient
lding and a considerable endowment were given by Joseph E.
ffield, Esq., of New Haven, whose name at the repeated
uest of the Corporation of Yale College, was afterward
ached to the foundation. Mr. Sheffield afterward frequently
l munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national

grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and Metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.

Maps and Charts, topographical, hydrographical, geological, etc.

he herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the ollege and Society libraries, the College Reading Room, the chool of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of bout five thousand volumes. Included in this is the "Hillhouse lathematical Library" of twenty-four hundred volumes, collected uring a long series of years by Dr. William Hillhouse, and in 870 purchased and presented to the Institution by Mr. Sheffield. catalogue of this collection forms a supplement to the Annual eport of the Governing Board for 1870. All the prominent sci-ntific journals of this country and of Europe, together with the roceedings of foreign academies, and scientific societies, can be ound either in this library or in the College Library to which udents have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, ere or elsewhere, may avail themselves of the facilities of the chool for more special professional training in the physical sci-nces and their applications, gaining in one, two, or three years he degree of BACHELOR OF PHILOSOPHY, or, in two additional ears of Engineering study, that of CIVIL ENGINEER, or of YNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, hey may become candidates for the degree of DOCTOR OF PHILOS-PHY. The instruction in such cases will be adapted to the par-icular needs and capacities of each student, and may be combined

with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the miscroscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, ıay obtain the degree of CIVIL or of DYNAMIC ENGINEER at the ıd of two academical years, by pursuing the following higher ɔurse of study and professional training.

The course of study for the degree of CIVIL ENGINEER will ɔmprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and ractice, the candidate will be required to furnish a comprehensive eport of the results of an examination into the existing condition f some special line of constructive art; or to present proper evi- ence that he has had actual charge in the field, for several ıonths, of construction or surveying parties, or held some respon- ible position deemed equivalent to this.

An elaborate design must also be submitted of some projected vork of construction, based upon exact data obtained from care- ul surveys made by the candidate, and comprising all the requi- ite calculations, and the necessary detailed drawings, and accom- anied by full specifications of the work to be done, and the equirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will omprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ uch a portion of their time as may be deemed advisable or neces- ary in the examination of engineering works and manufacturing stablishments, and may also have the privilege of entering upon ɔrofessional practice, provided it is done with the knowledge and ɔnsent of the Professor of Dynamic Engineering, and under such ircumstances as shall appear to him to be favorable to profes- ional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must not be less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar amount of Ovid.)

Arithmetic—Fundamental Operations. Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube *Roots.*

lgebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

eometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

igonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's or Richards's or Wentworth's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for mission are urgently advised to make themselves as familiar as possible with at subject; as a knowledge of it is essential to the most successful prosecution some of the studies of the course.

Candidates will be allowed the option of passing on the above-amed subjects in two successive years. In such cases they must resent themselves for examination at the June examination of ie first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, nd Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candiates must pass satisfactorily on four of the subjects; and notice f the intention to divide the examination must be given to Prossor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently pubshed text-books of Professor Newcomb (Henry Holt & Co., New York) may, ithout indicating undue preference, be especially recommended. And to the ndidate who prepares in other works, they may serve to indicate the extent and id of attainments expected in the prescribed topics. Candidates who prepare the Geometry of this author, may for the present omit the short chapters on ipse, Hyperbola, and Parabola; though they will find it advantageous to study m.

n his preparation in GEOMETRY the candidate should, as far as practicable, e suitable exercises in proving simple theorems and solving simple problems himself. It is important, too, that he should be accustomed to the numerical lication of geometric principles, and especially to the prompt recollection and of the elementary formulæ of mensuration. In TRIGONOMETRY he should be rcised in applying the usual formulæ to a variety of simple reductions and nsformations, including the solution of trigonometrical equations. Readiness accuracy in trigonometrical calculations are also of prime importance to the didate. If the use of *logarithms* is postponed in his preparation till Trigo-

nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1884 take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 26, 27, 28 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 16, 17 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1884 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, in St. Louis, and in San Francisco (beginning on Thursday, June 26, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Study;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior year the students select for themselves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's Manual. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies: Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses. Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals. Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of Pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts—continued. Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Botany. Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses or recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology. Geology*—Dana's Manual. *Zoology*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Bright's History of England. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Astronomy. Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Bright's History, continued: History of the United States. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various

teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are suggestively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they *have learned*, and the collections they have made are considered *to be of* minor importance.

In Zoology excursions are made during the Summer term of nior and Fall term of Senior year, in company with the tructors, for the purpose of observing the habits and making lections of marine, fresh-water, and terrestrial animals of all sses. Each student is required to prepare and present for amination a collection containing a specified number of species, d illustrating the various classes of animals. He must also be le to pass an examination upon his collection, at least to the tent of explaining the classes and orders illustrated, and show- g why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining ological phenomena and making special collections of rocks and nerals. Each student is required to pass a satisfactory exam- ation on his collection at the end of the first term of Senior ar.

In Civil Engineering the students, besides attending on Class citations and lectures, pursue a systematic course of exercises the different branches of Geometrical Drawing and Graphical atics, and in the application of the principles of drawing to rks of construction; and have good practice in the operations Surveying and Field Engineering—acquiring facility in the e and adjustment of Surveying and Engineering Instruments. Topographical Surveying they are instructed in the use of the ane Table for topographical work, and are required to prepare letailed chart of the ground surveyed—exhibiting the contour es and all its topographical features. Numerous problems of mputation, and graphical exercises, are included in the Course Construction pursued in the Senior year. A course of Blow- pe Analysis is also taken by the Senior Class, that a more thor- gh knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by reci- tion and lectures, supplemented by work in the drawing room, shop visits, and visits of inspection in and out of the city, and tests with the indicator and dynamometer. The lectures are ustrated by models, by large cartoons adapted for the purpose, id by the complete collection of working drawings of the Nov- ty Iron Works, owned by the School. In the drawing room, tailed working drawings of various machines are made. A neral sketch of the proposed machine is given and complete tailed drawings are required, in proper shape for the pattern- aker or machinist. The student is taught the best practice,

and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition of $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the overning Board, are admitted by the Corporation of Yale Col-ge to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of ıe three-years courses of study, passing all the examinations in satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including ıe fee for Triennial Catalogues, Commencement Dinners, etc., is 0; unless the person taking the degree is also an academical ·aduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The require-ents for these degrees are stated on page 19.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree 'e stated on page 17.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 18, 1884. he first term begins twelve weeks from Commencement-day and ›ntinues thirteen weeks: the second term begins regularly on ıe first Thursday in January and continues until Commence-ıent-day, with a spring recess—usually of eight days—including aster. (See Calendar, p. 2.)

XII.

NNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of ıe bestowal upon it of the Congressional grants are designed to id young men who are in need of pecuniary assistance in fitting ıemselves for agricultural and mechanical pursuits of life. All pplicants must be citizens of Connecticut. In case there are ıore applicants than vacancies, candidates will be preferred who ave lost a parent in the military or naval service of the United tates, and next to these such as are most in need of pecuniary ssistance; and the appointments will be distributed as far as

practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 24, 1884, and at or about the same time in the year 1885, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

APPENDIX

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1883, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JUNE, 1883.

1. Find the greatest common divisor of 36864 and 20736.

2. Multiply $\frac{3}{4}$ of $\frac{8\frac{4}{5}}{6\frac{2}{5}}$ by $\frac{4}{9}$ of $\frac{\frac{2}{7}}{16}$.

3. (*a*) Give the table of Metric weights.

(*b*) A cubical cistern holds 1331 kilograms of water: what is the length of an inner edge?

4. Divide 67.56785 by .035 and multiply the result by $\frac{7}{8}$. Explain the position of the decimal point after division.

5. How much money should be received on a note of $1000, payable in 4 months, discounting at a bank where the interest is 6 per cent.?

6. If a man travel 117 miles in 15 days, employing only 9 hours a day, how far would he go in 20 days, traveling 12 hours a day?

7. Extract the square root of 10 to five places.

ARITHMETIC.

SEPTEMBER, 1883.

1. (*a*) Select the prime numbers between 50 and 100.

(*b*) What is the least number that can be exactly divided by $\frac{1}{15}$, $2\frac{1}{2}$, 5, $6\frac{1}{3}$ and $\frac{1}{11}$.

2. Reduce 0.00096 to its simplest equivalent common fraction.

3. 7465 is $33\frac{1}{3}$ per cent. of what number?

4. A broker bought 84 shares of railroad stock at 19 per cent. discount. He sold 35 shares at $27\frac{1}{2}$ per cent. discount, and the balance at 8 per cent. discount. Did he gain or lose, and how much?

5. Calculate the cube root of 3.7 to five decimal places.

6. Give the approximate value of the meter in feet; of the kilogram in pounds avoirdupois.

7. Find the weight in kilos of 15 gallons of water.

GEOMETRY.

JUNE, 1883.

NOTE 1.—Candidates for examination on the whole of this subject should take the whole of this paper. Candidates for the first year's partial examination should take the first part; those for the second year's partial examination, the second part.

NOTE 2.—State what text-book you have studied on the subject, and to what extent.

I.—PLANE GEOMETRY.

1. (*a*) Define the symmetry of a figure with respect to a point and with respect to an axis.

(*b*) Determine the symmetrical figure of a triangle with respect to a point lying within and with respect to an axis cutting the triangle.

2. The three perpendiculars from the vertices of a triangle to the opposite sides meet in the same point.

3. To construct a polygon similar to a given polygon, the ratio of similitude of the two polygons being given.

4. (*a*) What is the area of a circle circumscribed about a square whose side is a?

(*b*) What must be the diameter of a circle in order that the length of its circumference may be 100 feet?

5. To find the locus of the point from which a given line subtends a right angle.

6. Of all triangles having the same base and equal areas, that which is isosceles has the minimum perimeter.

II.—SOLID AND SPHERICAL GEOMETRY.

7. Between two lines not in the same plane one, and only one, common perpendicular can be drawn.

8. All parallelopipeds having the same base and equal altitudes are equal in volume.

9. Show that opposite spherical triangles are symmetrical. If two symmetrical spherical triangles are isosceles, they are identically equal.

10. Write expressions for the lateral area and volume of the prism and regular pyramid: also for the entire surface and volume of the right cylinder and sphere.

GEOMETRY.

SEPTEMBER, 1883.

[State what text-book you have studied, and to what extent.]

1. Every point in the bisector of an angle is equally distant from the sides of the angle; and every point within the angle, but not on the bisector, is nearer that side toward which it lies.

2. If the sum of two opposite angles of a quadrilateral is equal to two right angles, the vertices of the four angles lie on a circle.

3. (*a*) Write expressions for the area of the triangle, parallelogram, trapezoid and circle.

(*b*) The areas of similar figures are to each other in what ratio?

(*c*) How would you find the area of any quadrilateral?

4. (*a*) When is a variable magnitude said to have a *limit?* Give an example to illustrate the definition.

(*b*) Apply the theory of limits to show that the area of a circle is equal to half the product of its circumference by its radius.

5. If from any point perpendiculars be dropped upon two intersecting planes, the angle between these perpendiculars will be equal to the dihedral angle between the planes, adjacent to the angle in which the point is situated.

6. The area of a spherical triangle is proportional to its spherical excess.

7. Required the entire surface and volume of a right cone whose altitude is 12 feet, and the diameter of its base 15 feet.

8. The radius of a sphere is bisected at right angles by a plane. What is the ratio of the two parts into which the plane divides the spherical surface?

ENGLISH GRAMMAR.

JUNE, 1883.

1. Define the *subject* and the *predicate* of a sentence.

2. Give the two methods of comparing the adjective.

3. State the distinction existing between the old (or strong) and the new (or weak) conjugation of the verb, and give three examples of verbs of each conjugation.

4. Parse the words in the following sentence:

He, by whom the sword of the law is borne, is himself the law's servant, and not its master.

ALGEBRA.

JUNE, 1883.

NOTE 1.—Candidates for examination in this subject as a whole should take the ole of this paper; those for the first year's partial examination, the first part of those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on subject, and to what extent.

I.

1. Reduce to their simplest forms the fractions

(1) $\frac{ac+bd+ad+bc}{af+2bx+2ax+bf}$; (2) $\frac{ax^m-bx^{m+1}}{a^2bx-b^2x^2}$.

2. Given $\frac{ace}{d}-\frac{(a+b)^2x}{a}-bx=ae-3bx$ to find x.

3. A sum of money, at simple interest, amounted in m years to lollars, and in n years to b dollars. Find the sum and the rate interest.

4. Prove that if $\frac{x-y}{m}<1-\frac{x}{y}$, and m is positive then $x<y$.

5. (1) Simplify $(a^2b^3)^{\frac{1}{3}}+(a^3c^6)^{\frac{1}{3}}$.

(2) Extract the square root of $6hm^{2n}+h^2+9m^{4n}$.

(3) Reduce $\frac{\sqrt{x+a}+\sqrt{x-a}}{\sqrt{x+a}-\sqrt{x-a}}$ to an equivalent fraction with ational denominator.

II.

3. Given $15x^2-20x=35$ to find x.

7. Given $\frac{x+\sqrt{x^2-9}}{x-\sqrt{x^2-9}}=(x-2)^2$ to find x.

8. Given $x^2-xy=48$, and $xy-y^2=12$ to find x and y.

9. The number of permutations of n things taken r together is al to 10 times the number when taken $r-1$ together; and the nber of combinations of n things taken r together is to the nber when taken $r-1$ together as 5 to 3: required the value and r.

10. Expand $\frac{3+2x}{5+7x}$ into a series of ascending powers of x, by method of indeterminate co-efficients. (Four terms of the es will be sufficient.)

ALGEBRA.

SEPTEMBER, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Given $\frac{x-y+1}{x-y-1}=a$, and $\frac{x+y+1}{x+y-1}=b$, to find x and y.

2. Simplify (1) $\sqrt{27}+2\sqrt{48}+3\sqrt{108}$. (2) $(\sqrt[7]{a^2b})^3(\sqrt[7]{a^3b^{13}})^4$.

(3) $\frac{x^{2p(q-1)}-y^{2q(p-1)}}{x^{p(q-1)}+y^{q(p-1)}}$.

3. From an equation whose roots shall be 2 and -3. Resolve x^2-3x+4 into two factors.

4. Given $\frac{1}{x}+\frac{1}{y}=5$ and $\frac{1}{x^2}+\frac{1}{y^2}=13$ to find x and y.

5. Given $\frac{3x+\sqrt{4x-x^2}}{3x-\sqrt{4x-x^2}}=2$ to find x.

6. To deduce a formula for the sum of a geometric progression in terms of the first term, the ratio, and the number of terms.

7. Having 10 different letters, how many sets of two each can you form of them, differing by at least one letter.

8. Expand $\frac{1}{1-2x+x^2}$ into a series of ascending powers of x by the method of indeterminate coefficients. (Four terms of the series will suffice.)

9. Express $\log \sqrt[3]{\frac{ab^2c^4}{d^5}}$ in a form adapted to computation.

10. To deduce a formula for the amount of a given sum of money for a given time at a given rate of compound interest.

TRIGONOMETRY.

JUNE, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Explain the circular measure of an angle. Express an angle of 1.5 in degrees.

2. Give the algebraic signs of the Trigonometric functions for angles terminating in each of the four quadrants, and the values of the functions of $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$.

3. State some of the fundamental relations existing between the ferent functions of the same angle.

4. Find an angle whose tangent is double its sine.

5. Write the different formulas which serve to solve right-gled triangles, and explain their application.

6. Find a formula for expressing $\sin \frac{1}{2}\alpha$ in terms of $\cos \alpha$.

7. If a, b, and c are the sides of a triangle and α the angle opsite the side a, show that

$$a^2 = b^2 + c^2 - 2bc \cos \alpha.$$

so state any application you have made of this formula.

8. In a triangle given $A = 32°$, $a = 40$, $b = 50$, to find one so-:ion of the triangle. Is there more than one? If so, how do ·u recognize the fact?

TRIGONOMETRY.

SEPTEMBER, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Express an angle of 75° in radius.

2. Express each of the functions of $\left(\frac{\pi}{2} + \alpha\right)$ by a function of α.

3. Form a general expression for all angles which have the ne cosine.

4. What must the value of the cosine be in order that the tan-nt may be n times the sine?

5. To find a formula for the tangent of the sum of two angles terms of the tangents of the angles; and from this formula to ·ive an expression for the tangent of twice an angle in terms of tangent of the angle.

6. In a triangle ABC, given the angle $A = 118° 04'$, and the jacent sides, $b = 960$, and $c = 1686$, to find the remaining angles d side of the triangle.

LATIN.

JUNE, 1883.

I. Translate as literally as possible:

a. Ubi de ejus adventu Helvetii certiores facti sunt, legatos ad eum mittunt, nobilissimos *civitatis*, cujus legationis Nameius et Verudoctius principem locum obtinebant, qui dicerent, *sibi* esse in animo sine ullo maleficio iter per provinciam facere, *propterea quod aliud* iter haberent nullum.

b. Temporis tanta fuit exiguitas hostiumque tam paratus ad dimicandum animus, ut non modo ad ***insignia*** accommodanda, sed etiam ad galeas induendas scutisque tegimenta detrudenda tempus defuerit. Quam quisque ab opere in partem ***casu*** devenit, quaeque prima signa conspexit, ad haec constitit, ne in quaerendis suis pugnandi tempus dimitteret.

c. Hac re perspecta, Crassus, quum sua cunctatione atque opinione timoris hostes nostros milites alacriores ad pugnandum effecissent, atque omnium voces audirentur, ***exspectari*** diutius non ***oportere***, quin ad castra iretur, cohortatus suos, omnibus cupientibus, ad hostium castra contendit.

d. Genus hoc est ex essedis pugnae: primo per omnes partes perequitant et tela conjiciunt, atque ipso ***terrore*** equorum et strepitu rotarum ordines plerumque perturbant, et quum se inter equitum turmas insinuaverunt, ex essedis desiliunt et ***pedibus*** proeliantur.

e. Qua re animadversa, Ambiorix pronuntiari jubet, ut procul tela conjiciant, neu propius accedant, et quam in partem Romani impetum fecerint, cedant (levitate armorum et quotidiana exercitatione ***nihil iis*** noceri posse), rursus se ad signa recipientes insequantur.

f. Erat aeger in praesidio relictus Publius Sextius Baculus, qui primum pilum ad Caesarem duxerat, cujus mentionem superioribus proeliis fecimus, ac diem jam quintum ***cibo*** caruerat. Hic diffisus suae atque omnium saluti ***inermis*** ex tabernaculo prodit: videt imminere hostes atque in summo esse rem discrimine: capit arma a proximis atque in porta consistit.

II.—1. Decline *adventu* (1), *principem* (3), *ullo* (4).

2. Compare *certiores* (1); *nobilissimos* (2), *prima* (10).

3. Write the synopsis, active and passive, of ***mittunt*** (2).

4. Parse in full each word in the last two lines of passage *b*.

5. Give the principal parts of the following: ***obtinebant*** (3), *detrudenda* (8), *effecissent* (14), *oportere* (15), *iretur* (15), *contendit* (16), *conjiciunt* (18), *desiliunt* (20), *cedant* (24), ***noceri*** (25), *relictus* (27), *diffisus* (30).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

LATIN.

SEPTEMBER, 1883.

I. Translate as literally as possible:

a. Is ita cum Caesare agit: Si pacem populus Romanus cum Helvetiis faceret, in eam partem ituros atque ibi futuros Helvetios, ubi eos Caesar constituisset atque esse voluisset; sin *bello* persequi perseveraret, reminisceretur et veteris *incommodi* populi Romani et pristinae virtutis Helvetiorum.

b. Caesar quum septimam legionem, quae juxta constiterat, item urgeri ab hoste vidisset, tribunos militum monuit, ut paulatim sese legiones conjungerent et conversa signa in hostes inferrent. Quo facto, quum *alius alii* subsidium ferrent, neque timerent ne aversi ab hoste circumvenirentur, audacius resistere ac fortius pugnare coeperunt.

c. Una erat magno *usui* res praeparata a nostris, falces praeacutae, insertae affixaeque *longuriis*, non absimili *forma* muralium *falcium*. His quum funes, qui antennas ad malos destinabant, comprehensi adductique erant, navigio remis incitato praerumpebantur.

d. Caesar questus, quod, quum ultro in continentem legatis missis pacem ab se petissent, bellum sine causa intulissent, ignoscere *imprudentiae* dixit obsidesque imperavit; quorum illi partem statim dederunt, partem ex longinquioribus locis arcessitam paucis diebus sese daturos dixerunt.

e. His circumventis, magna manu Eburones, Nervii, Aduatuci atque horum omnium socii et clientes legionem oppugnare incipiunt: nostre celeriter ad arma concurrunt, vallum conscendunt. Aegre is dies sustentatur, quod omnem spem hostes in celeritate ponebant atque hanc adepti victoriam in perpetuum se fore *victores* confidebant.

f. Multum quum in omnibus rebus, tum in re militari potest fortuna. Nam sicut magno accidit casu, ut in ipsum incautum etiam atque imparatum incideret, priusque ejus adventus ab hominibus videretur, quam fama aut nuntius afferretur; sic magnae fuit *fortunae* omni militari *instrumento*, quod circum se habebat, erepto, rhedis equisque comprehensis, ipsum effugere mortem.

II.—1. Decline *bello* (4), *veteris* (4), *alius* (9).

2. Compare *veteris* (4), *audacius* (10), *fortius* (11).

3. Write the synopsis, active and passive, of *agit* (11).

4. Parse in full each word in the last two lines of passage *d*.

5. Give the principal parts of the following: *voluisset* (3), *persequi* (4), *reminisceretur* (4), *inferrent* (9), *aversi* (10), *insertae* (13), *comprehensi* (16), *praerumpebantur* (16), *questus* (17), *petissent* (18), *adepti* (26), *erepto* (33).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an illustration of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1883.

1. The envoys[1] come[2] to[3] Caesar.[4]

2. The envoys will come to Caesar.

3. Caesar sends back[5] the envoys immediately.[6]

4. The envoys were immediately sent back by Caesar.

5. The envoys, who[7] came to Caesar, were immediately sent back.

6. If[8] the envoys had come to Caesar, they would have been immediately sent back.

7. Caesar forms[9] the design[10] of sending back the envoys. (Use gerundive construction.)

8. (Rewrite sentence seventh and use gerund instead of gerundive.)

9. It is said, "Caesar has sent back the envoys."

10. (Rewrite sentence ninth so as to employ indirect statement.)

[1] legatus. [2] venīre. [3] ad [4] Caesar. [5] remittĕre. [6] statim. [7] qui. [8] si. [9] capĕre. [10] consilium.

LATIN EXERCISES.

SEPTEMBER, 1883.

.e Helvetians[1] burn[2] four hundred[3] villages.[4]
ur hundred villages are burned by the Helvetians.
ıe Helvetians will burn four hundred villages.
ur hundred villages will be burned by the Helvetians.
esar[5] says[6] (that) the Helvetians have burned four hun-
lages.
ewrite sentence sixth and substitute direct statement.)
ıe Helvetians formed[7] the plan[8] of burning four hundred
. (Use the gerundive construction.)
ewrite sentence seventh and use gerund instead of ge-
.)
ıe Helvetians say they will burn four hundred villages.
Rewrite sentence ninth so as to illustrate direct state-

vetius. [2] incendĕre. [3] quadringenti. [4] vicus.
:. [6] dicĕre. [7] capĕre. [8] consilium.

HISTORY OF THE UNITED STATES.

JUNE, 1883.

ive in chronological order the following dates: La Salle's
tion of the Mississippi; Battle of the Brandywine; Presi-
of John Quincy Adams, Van Buren, Taylor; King
; War; Frobisher's first voyage; Settlement of Jamestown.
escribe the settlement of New York, and explain the
of its name.
ow the differences between royal, proprietary and char-
nies.
ive with their dates the principal events that led to the
of the colonies from the passage of the stamp act to the
of Lexington.
hat were the Virginia and Kentucky resolutions, and by
ere they occasioned?
ate the causes and the general results of the Mexican war.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1883.

1. Give in chronological order the following dates: Battle of Lundy's Lane; Settlement of Maryland; Invasion of Mexico; Trials for witchcraft at Salem; Presidencies of Polk, Buchanan, Jackson; Emancipation of the slaves.

2. Give an account of the foundation of the Connecticut and New Haven colonies.

3. When, for what purpose, and on what terms was the New England confederation formed?

4. Give the date, causes and results of the French and Indian war.

5. When was the treaty of Ghent made, and what were its provisions?

6. Give an account of the compromise of 1850, and the questions which it was intended to settle.

GEOGRAPHY.

JUNE, 1883.

1. Bound the State of Colorado; give the names of two rivers in it, and tell where they rise, run and empty; give the name of one city in it and tell where it is situated.

2. If we travel due south from lake Michigan to the gulf of Mexico, what States should we touch?

3. Bound France; give the names of two rivers in it, and tell where they rise, run and empty; give the names of two cities in it and tell where they are situated.

4. Where are the following cities: Santiago, Salem, Singapore, Sacramento, Sydney, Savannah?

5. What States and Provinces touch lake Erie? Give the names of three rivers that empty into it and tell where they come from.

6. Give the names of four seaports in Asia, tell what countries they are in and how they are situated.

GEOGRAPHY.

SEPTEMBER, 1883.

1. Bound the State of Michigan; give the names of two cities in it and tell where they are situated.

2. If we travel due west from North Carolina to the Pacific Coast what States and Territories should we touch?

3. Bound Russia; what is its capital and where is it situated; give the name of one other city in Russia and tell where it is situated.

4. Where are the following cities: Manchester, Manila, Marseilles, Madrid, Memphis, Minneapolis?

5. What countries of Africa touch the Atlantic ocean? Give their names in their order from north to south.

6. Give the names of four seaports in South America, tell what countries they are in and how they are situated.

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NINETEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1884-85.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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1885.

STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

His Excellency THOMAS M. WALLER, New London.

Lieutenant-Governor.

His Honor GEORGE G. SUMNER, Hartford.

State Senators.

Hon. LORIN A. COOKE, Barkhamsted.
Hon. JOSEPH W. ALSOP, Middletown.
Hon. EBENEZER C. DENNIS, Stafford.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

REPORT

OF THE

STATE BOARD OF VISITORS.

the General Assembly of the State of Connecticut:

The Governor, Lieutenant-Governor, three senior Senators
l the Secretary of the Board of Education, comprise the
te Board of Visitors of this institution.

These officials, with the Secretary of the school and the
retary of the State Board of Education, have the selection
students to fill the State scholarships. This discretion is
rcised in accordance with rules that experience has proven
)e fair and impartial, and to best subserve the policy of the
te in relation thereto.

The Governing Board of the School is appointed by the
e College Corporation. Their nineteenth annual report,
have the honor of herewith presenting, is in every way
ifying. Its exhibit of the work this institution is doing,
the prosperity it is enjoying, is evidence of the ability and
otion of its managers, professors and teachers, and the
wing appreciation in the country of the scientific, indus-
l and technical education, this school affords.

THOMAS M. WALLER,
Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

HE SHEFFIELD SCIENTIFIC SCHOOL has on its rolls for the ·ent academic year the largest number of names it has ever ı able to report. Ten years ago the attendance was nearly as ·e. The business depression, however, which resulted from financial crisis of 1873, made, in course of time, its consences felt in this as in all institutions of learning whose courses study are more or less intimately connected with the de·pment of the industrial resources of the country. The num- of students fell off gradually, so that in 1879 there were · 177 reported in attendance. From this time, however, the ber began steadily to increase. In presenting to the Legisla-, their Nineteenth Annual Report, it is gratifying for the erning Board to be able to say that the highest point ever re reached has now been passed. It is the more gratifying hem to make the announcement, because they are able to say ıe same time that the recovery from this temporary depression not been due in the slightest to any lowering of the require-ts for admission or for graduation. Nor has the establish-t of several other institutions of a similar nature throughout country interfered either with the growth of this School or ted the field from which it draws its support. The table on ± 13 shows that its students come from no particular locality, that while in one sense it is an institution of this State, *tracts men from all* quarters of the Union.

Addition to the Corps of Professors.

The unexpected and sudden death of Professor Norton at the beginning of the academic year 1883–4 was mentioned in the last Annual Report. The department of Civil Engineering was left, in consequence, without a head. By great good fortune the Governing Board were at once enabled to secure the services of capable and experienced instructors, and a temporary arrangement was also made by which Professor DuBois was put in charge of the departments of both Civil and Mechanical Engineering. This was intended to continue only until the end of the last academic year, and during the course of it a satisfactory arrangement was reached, which it is believed will be productive of great permanent benefit to the School. Professor DuBois was at his own request transferred from the department of Dynamic to that of Civil Engineering, the latter being the one to which he had originally devoted himself. This left the former vacant. To fill this position the Governing Board have been fortunate enough to secure the services of Mr. Charles B. Richards, one of the best-known mechanical engineers in the country. Mr. Richards' life has been largely spent in positions connected with the great manufacturing establishments of the United States. From 1869 to 1880 he was the Engineering Superintendent of the Colt's Patent Fire Arms Manufacturing Company at Hartford, and from 1880 to 1884 he held the place of Superintendent of the Southwark Foundry and Machine Company at Philadelphia. Learning of his willingness to accept a call to this institution, he was at once recommended by the Governing Board to the professorship of Dynamic Engineering, and to that position he was elected by the Corporation of the College at their meeting on February 19, 1884. He entered upon his duties at the beginning of the present academic year.

As Professor Lyman had signified his desire to be relieved of a certain portion of his duties, the chair of Physics and Astronomy was at his suggestion divided, and an independent professorship of Physics created. To this Mr. Charles S. Hastings was elected at the meeting of the Corporation above mentioned, Professor Lyman retaining the department of Astronomy. Mr. Hastings was a member of the class of 1870 in the Scientific School. After receiving his degree of Bachelor of Philosophy he pursued a course of graduate study in physics and astronomy, obtaining in

1873, from Yale College, the degree of Doctor of Philosophy. For the purpose of still further prosecuting his special studies, he went in 1873 to Europe, and spent two years in Germany and one in France. Returning to this country in 1875 he was made associate in Physics in Johns Hopkins University, and in 1882 was appointed associate Professor of Physics in the same institution. In 1883 he went to the Caroline Islands in charge of the spectroscopic observations of the eclipse of the sun which took place May 6, of that year, in the expedition sent out by the National Academy under Professor E. S. Holden. Resigning his professorship in Johns Hopkins University to accept the one established in this School, he likewise entered upon his duties at the beginning of the academic year.

Addition to the Laboratory of Physiological Chemistry.

It has been found advisable during the past year to give additional space to the laboratory of Physiological Chemistry. Increasing numbers of students in the biological course has rendered this step necessary, especially as it has seemed desirable to provide suitable accommodations for advanced work in this department of chemistry. A larger number of graduate students than ever before are engaged in research and it is to be hoped that with the present increased laboratory facilities still larger numbers may enter upon a course of advanced study in this department, which promises so much to students preparing for the medical profession.

The necessary space for a new laboratory, in a building already crowded, was to be found only by dismantling a former recitation room adjoining the old laboratory. This, however, has given a commodious and well lighted work room, quite well adapted to the purposes for which it is intended. The new laboratory has accommodations for twelve students in addition to the common space which necessarily forms an integral part of a well equipped laboratory. The additional room thus acquired gives to the biological course better advantages for successful work, and renders possible a more thorough study of many physiological problems.

It may be of interest in this connection to state that there are now in South *Sheffield Hall* but two recitation rooms remaining.

One by one, as occasion has demanded, they have been converted into laboratories until now nearly the entire building is given up to the study of Chemistry in its various branches. This fact suggests that with increasing numbers of students in the School an additional building for chemistry will soon become an imperative necessity.

Additions to the Department of Physics.

The physical apparatus of the Sheffield Scientific School, though admirably adapted to the purposes of demonstration in the ordinary course of undergraduate lectures in most subjects, and even exceptionally rich in certain departments, was deficient in instruments for exact measurements, especially in the field of magnetism and electricity. To supply this defect the trustees appropriated a thousand dollars for the more immediate demands. This sum has been expended during the past year under the direction of the professor of physics. A large portion of the new apparatus was bought in Germany, but French manufacturers have contributed a part, and another portion has been designed by and constructed under the direction of the professor. This last course has been pursued only when satisfactory designs were lacking in the workshops of professional instrument-makers, or when the cost of such designs was excessive. It is believed that this plan and a fortuitously extensive acquaintance with the recent products of the leading instrument-makers of Europe, have rendered the purchases as economical as is consistent with perfect efficiency.

Among the more important additions may be named—

1. A reversible pendulum.
2. An electrical condenser for quantitative measurements, which can also be used for Volta's fundamental experiment.
3. A magnetometer.
4. An earth inductor.
5. A large universal galvanometer of a recent form, made by Hartmann, of Würtzburg.
6. A Wheatstone's bridge of the Kohlrausch form, by the same maker.
7. Two sets of resistance coils from 0.01 to 10,000 ohms.
8. Reading telescope and scales.
9. A quadrant electrometer, by Dr. Söhrer & Son, of Leipsic.
10. An ammeter.

11. A magneto-electric machine of the Gramme form, by eguet.

To these may be added a fine grating of about 45,000 lines on ɔculum metal, a gift to the institution from Professor Rowland, the Johns Hopkins University; an accurate clock with electrical ıtact to make circuit every second, and, in process of construcn, a grating spectroscope and a heliostat.

Besides the sum above named the School has devoted sufficient ɔney to purchase and mount a dynamo machine and secondary ttery of fifty cells. This machine, which is to provide elecɔity for all the laboratory and lecture-room experiments where ong currents are demanded, has already been ordered. It is to sorb two horse power of work. To drive it a four horse power gine is to be used which belongs to the department of Dynami- Engineering, the gift of Mr. Frank Bigelow. All of this ıt-mentioned apparatus will find a place in the room in the baseɔnt of the North Sheffield Hall which was formerly used by the ɔrological Bureau. The boiler which is to supply steam to the gine is also in part a gift from Messrs. Bigelow & Son, and is be placed in the adjoining cellar near one of those used for ɜating the building.

Gifts.

The last annual Report announced that Dr. Beverley Livington, of the class of 1874, had left to the School at his death his aluable scientific collections, consisting of books, journals, microcopic slides, and cryptogamous plants. From the same source further gift has since been received. Mr. Francis A. Livington, the father of the deceased, has presented to the permanent und of the institution three thousand dollars, which had been ccumulated by his son. This disposition of his property was ıade in accordance with the owner's request.

From the clerk of the Probate Court of the Plainfield district, ıe Governing Board has received an attested copy of part of the ill of the Hon. David Gallup. The clause relating to the Shefɔld Scientific School reads as follows:

"I give, devise and bequeath to the President and Fellows of ale College one-fifth part of my said estate, and direct my ɜecutors to distribute the same to them if they accept it, on the llowing *conditions, viz.:* Said property shall be invested in a

permanent fund to be known and called the David Gallup fund. The annual income of said fund shall be appropriated in paying the tuition of such young men residing in the State of Connecticut as shall be scholars in that department of said College known as the Sheffield Scientific School for a term of time not less than three months during the year, and who are not beneficiaries of the State in said department, and in case said income is not sufficient to pay the whole of said tuition, then it is to be apportioned to the payment of each scholar's tuition during the year whose attendance as a scholar in said school is in compliance with provisions herein expressed—as his attendance during said year bears to the whole attendance in said year under these provisions. And in case there shall be an excess in any year of the income of said fund over and above the tuition for the year, it shall be added to the principal of the fund until the principal is doubled, then any excess may be used for the benefit of said School."

In the last annual Report mention was also made of a gift of books to the library of the Scientific School by Professor Wolcott Gibbs, of Harvard University. The following is a catalogue of the works presented :

	No. Vols.
Smithsonian Reports for the years 1860, '70, '72, '76, '77	5
Petermann's Geographische Mittheilungen, 1855, '56, '57, '58, '59, '60, '61, '62, '63, '64, and Ergänzungsband for 1860–'61, 1862–'63, 1863–'64	13
Proceedings of the American Philosophical Society, Nos. 73, 81, 82, 84, 86, 88, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 112	27
List of Members	3
Bulletins of the Department of the Interior: Report of Entomological Commission, Nos. 3 and 6 (2 vols.)	3
Bulletins of the Survey of the Territories, Vol. II., Nos. 1, 2, 4; Vol. III., Nos. 1, 2, 3; Vol. IV., Nos. 1, 2; Vol. V., Nos. 1 (2 vols.), 2 (2 vols.), 3, 4; Vol. VI., Nos. 1, 2, 3; Miscellaneous Publications, No. 1 (2 vols.); Series II., 1, 6, Extract (Gannett on Contour Map)	22
Wheeler, Survey West of 100th Meridian, Part VI., Vol. III.	1
Wheeler, Annual Report on same, 1874, '75	2
Memoirs of the National Academy of Sciences	1
Gould, Catalogue of Stars, Extract from same	1
Annals of Harvard Observatory, Vol. IV., Part II.; Vols. VI., VII., IX., XI., Parts I., II.	6
Washington Astronomical Observations, 1868	1
United States Naval Astronomical Expedition, 1849–'52, and Appendix	2
Herschel, Astronomy	1
Desagerliers, A Course in Experimental Philosophy	2
Mousson, Physik	1

	No. Vols.
ıtal Physik	1
; on International Monetary Conference, 1867	1
ıts de Physique	2
	1
l Physics	1
s of Chemistry	1
ss der Organischen Chemie	1
ıe Methoden	1
ehrbuch der Chemie	1
buch der Organischen Chemie	1
ch der Chemischen Technologie	2
	1
'racts	1
	4
s	1
phie	1
ise on the Microscope	1
and Acoustics	1
tical Mechanics	1
npendium der höheren Analyse	1
strations of Surface Geology	1
leological Report	1
and Coal in Pennsylvania	1
Department of Agriculture, 1878	1
rometers	1
ertations	1
rd's Manual	1
ary Commission of Europe	1
f War in Europe	1

DITIONS TO THE ZOOLOGICAL COLLECTIONS.

A. E. VERRILL, Curator.

important additions to the collections, as during sev-
ast, have been due to the coöperation of the curator
S. Fish Commission in the exploration of the deep sea
ıst. During the past summer the dredgings were
n the region of the Gulf Stream, from off Cape Hat-
e Cod, and from shallow water to 2600 fathoms, by
e steamer Albatross, Lieut. Z. L. Tanner commanding.
was organized nearly as in 1883. Very large collec-
ertebrata were made, and the larger part were sent
ntification and description, as in previous years.
tor has published during the year accounts of these
s *explorations* in the American Journal of Science, in

the Annual Report of the Fish Commission, and in Science. He has also published a detailed descriptive Catalogue of the deep-sea Mollusca, illustrated by several plates, in the Transactions of the Connecticut Academy. In this paper about 125 species are added to the fauna, a large part of them new.

Professor S. I. Smith has taken charge of the Crustacea, and has published in the Annual Report of the Fish Commission a report on the Crustacea dredged by the Albatross in 1883, and a shorter paper on the same subject in the American Journal of Science.

Mr. J. H. Emerton has published a paper on the New England spiders of the family Epeiridæ in the Transactions of the Connecticut Academy, with eight plates. He has also completed, for the museum, the model of the great California *Octopus*.

Miss K. J. Bush has continued the work of cataloguing and labeling the collections of shells, etc., dredged by the Fish Commission. She has also prepared for publication a list of the deep-sea shells dredged by the Fish Hawk, 1880 to 1882, and another on the shallow water shells dredged near Cape Hatteras in 1883.

Miss C. E. Bush has also been employed by the Fish Commission to work on the collections of Invertebrates in the museum.

The fishes of the Gulf of Mexico and South America have been worked up and returned by Professor D. F. Jordan and Mr. C. H. Gilbert. The results have been published in the Proceedings of the National Museum.

In addition to the collections dredged by the U. S. Fish Commission the following have been received :

Professor W. G. Mixter. Frog with but three legs, Iowa.

Dr. Street, New Haven. Young alligator.

W. E. Safford, U. S. N. Shells from China, etc. Hydroids from California.

Augustus Fifer, New Haven. Flounder with both sides pale, New Haven.

Professor J. D. Dana. A young seal, mounted.

R. Wells & Co., New Haven. Sea-fans and a very large, rare sea-urchin (*Metalia pectoralis*) from Nassau ; and cuttlefishes from the Mediterranean.

A. H. Verrill, New Haven. An albino mole (*Scalops*) killed in Hamden by Mr. Warner. Nests of hornet, potter-wasp, etc.

Professor B. Silliman. A living lizard from Arizona.

H. S. Barnum. Skin of lynx from Turkey.

J. J. Rivers. Bryozoa from California.

G. J. Brush. Young bat, in alcohol.

A. E. Verrill. Insects from Virginia, myriapods from Luray Cave.

Chas. H. Townsend, New Haven. Sections of a pile from long wharf, New Haven, bored by an unusual species of teredo (*Xylotrya fimbriata*). Young oysters showing rates of growth.

John B. Russell, Stony Creek. Orange file-fish and sea cat-fish.

A. H. Young, New Haven. Young skunk, living, East Haven.

Horace Bowman, New Haven. Fish and parasites, New Haven.

States Represented in the School.

The following table shows the States from which come the students whose names appear on the catalogue during the current year, and the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	1	3	--	1	5
2. Colorado	1	--	2	2	--	5
3. Connecticut	13	24	24	27	4	92
4. Dakota Territory	--	--	--	1	--	1
5. District of Columbia	--	--	1	1	--	2
6. Georgia	--	--	2	--	--	2
7. Illinois	--	3	6	6	--	15
8. Indiana	--	1	--	2	--	3
9. Kentucky	--	2	1	2	--	5
10. Maine	--	2	1	1	--	4
11. Massachusetts	--	--	--	2	--	2
12. Michigan	--	1	2	1	--	4
13. Minnesota	--	--	4	1	--	5
14. Missouri	--	4	2	--	--	6
15. Nebraska	--	1	2	2	--	5
16. New Jersey	1	1	1	1	--	4
17. New York	4	18	9	19	2	52
18. Ohio	1	4	3	4	2	14
19. Oregon	--	1	--	--	--	1
20. Pennsylvania	--	6	4	7	--	17
21. Rhode Island	--	--	1	--	--	1
22. Texas	--	--	1	1	--	2
23. Vermont	--	--	1	--	--	1
24. Wisconsin	--	--	1	--	--	1
25. Saxony, Germany	--	--	--	1	--	1
Total	20	69	71	81	9	250

To a certain extent these statistics are deceptive. Connecticut has always a *large* number added to what belongs to it legiti-

mately, from the fact that families come here from other States and take up a temporary residence for the sake of educating their children. Graduate students also frequently change their residences to New Haven.

Public Lectures.

The annual course of lectures to mechanics and others has been given during the past year. The lectures and their subjects are indicated in the annexed programme:

I. Tuesday, Feb. 26.—The Relation of Literature to Life. Mr. Charles Dudley Warner
II. Thursday, " 28.—Sunflowers and Kindred Plants. Prof. Daniel C. Eaton
III. Tuesday, March 4.—The Mormons and their Country. Prof. Brewer
IV. Thursday, " 6.—The Mormons and their Country. Prof. Brewer
V. Tuesday, " 11.—The Resources of Mexico. Mr. Alfred R. Conkling
VI. Thursday, " 13.—The Railroad Problem. Mr. Arthur T. Hadley
VII. Tuesday, " 18.—Muscles and Nerves. Prof. Chittenden
VIII. Thursday, " 20.—The Art of Seeing. Prof. Niemeyer
IX. Tuesday, " 25.—Science among the Arabians. Rev. Edward Hungerford
X. Thursday, " 27.—Flying and Flying Machines. Mr. Thomas W. Mather
XI. Tuesday, April 1.—Chemical Affinity. Prof. Johnson
XII. Thursday, " 3.—Earthquakes and Volcanoes. Prof. Verrill

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1883–84.

The order and subjects of the Lectures were as follows:

I. Monday, Feb. 25.—Strategy and Grand Tactics. 1st Lieut. James G. Warren, U. S. Engineers
II. Friday, " 29.—Logistics. 1st Lieut. James L. Lusk, U. S. Engineers
III. Monday, March 3.—Small Arms and their Influence on Tactics. 1st Lieut. Harry F. Hodges, U. S. Engineers
IV. Friday, " 7.—Artillery. 1st Lieut. John Biddle, U. S. Engineers
V. Monday, " 10.—Fortification. Capt. J. H. Willard, U. S. Engineers
VI. Friday, " 14.—Sea Coast Defense. Gen. H. L. Abbot, U. S. Engineers

Anniversary.

The Exercises of the Graduating Class were held in North heffield Hall on the evening of Tuesday, June 24, 1884. The ındidates for degrees with the subjects of the graduation theses : the Bachelors of Philosophy are given in the following sched- le. The names in the first list are of those who stood highest in ıeir respective courses. Those marked with an asterisk read ıeses in the evening.

Dynamic Engineer.

ERBERT WALDRON FAULKNER, *Stamford.* Steam Launch Calculations.

Bachelors of Philosophy. (43.)

AWRENCE VINCENT BENÉT (Civil Engineering), *Washington, D. C.* Review of the Michigan and New York Central Bridge over the Niagara River.

DWARD BLAKE (Dynamic Engineering), *New Haven.* On the Prevention of Induction in Telephone Wires.

HAUNCEY REA BURR (Select), *Portland, Me.* On the Irish Land Law of 1881.

ERBERT DEWITT CARRINGTON (Civil Engineering), *New Haven.* On the Theory of the Stone Arch.

OUIS EDWARD COOPER (Biology), *Ansonia.* On the Kidney of the Cat.

EORGE WYCKOFF CUMMINS (Biology), *Vienna, N. J.* On the Digestibility of Fish Flesh.

HARLES PERCIVAL FARQUHAR (Dynamic Engineering), *York, Pa.* On the System of Rapid Transit in New York.

ALVIN LINSLEY HARRISON (Biology), *New Haven.* On the Exoskeleton of *Platyonichus ocellatus.*

EDWARD MUSSER HERR (Dynamic Engineering), *Denver, Col.* On the Block, and Interlocking Railroad Signals.

AMES HENRY JENNINGS (Civil Engineering), *Redding.* On the Construction and Maintenance of Highways and Pavements.

ALBERT LUCAS (Chemistry), *Philadelphia, Pa.* On Rosin.

WILLIAM WALLACE NICHOLS (Dynamic Engineering), *Manitou Springs, Col.* On the Compound Engine with an original Design for a Compound Yacht Engine.

HERBERT LINCOLN NOYES (Chemistry), *New Haven.* On a Short Method of Separating a Small Amount of Zinc from a Large Excess of Iron.

WILLIAM TUTTLE SHEPARD (Civil Engineering), *Bristol.* On the Sinking of Foundations by the Use of Compressed Air.

AMES HENRY WARNER (Select), *Steubenville, O.* On Methods of Conducting Presidential Elections.

NDREW LINCOLN WINTON (Chemistry), *Bridgeport.* On the Chemical Composition of a Mineral from Fowler, N. Y.

GUSTAVO ALFONSO (Chemistry), *New York City.* On the Separation of Zinc and Nickel.

ELWOOD HARVEY ALLCUTT (Dynamic Engineering), *Kansas City, Mo.* On the Edison System of Incandescent Lighting.

ALBERT PARK CAMPBELL (Dynamic Engineering), *New Haven.* On the Theory of the Giffard Injector.

WILLIAM BRAINARD COIT (Select), *New London.* On the United States Weather Signal Service.

CLIFFORD LAURENCE COLTON (Civil Engineering), *Canton.* Review of the Chapel Street Bridge over West River.

ARTHUR BIXBY FERGUSON (Biology), *New Haven.* On the Nervous System of the Cat.

DAVENPORT GALBRAITH (Select), *Erie, Pa.* On Criminal Procedure in the United States and France.

MORGAN AUGUSTUS GUINNIP (Select), *Washington, D. C.* On the Silk Industry of the United States.

JOHN BELL HATCHER (Natural History), *Cooper, Iowa.* On the Genus of Mosses termed *Conomitrium.*

SAMUEL BROWN HAWLEY (Dynamic Engineering), *Yonkers, N. Y.* On Electric Lighting.

HENRY CLAY JOHNSON (Dynamic Engineering), *Rome, Ga.* On the Westinghouse Automatic Engine.

THOMAS CROSSLEY JOHNSON (Dynamic Engineering), *New Haven.* On the Manufacture of Iron and Steel.

EDSON KEITH, JR. (Dynamic Engineering). *Chicago, Ill.* On the Telephone.

DUANE JUDSON KELSEY (Dynamic Engineering), *Killingworth.* On the Transmission of Energy.

LUTHER JAMES MARTIN (Biology), *Norwich.* On the Vertebral Column, the Shoulder and Pelvic Girdles of the Cat.

GEORGE EDGAR MOULTHROP (Civil Engineering), *New Haven.* On the Niagara Falls Suspension Bridge.

ALBERT ANDERSON NOYE (Dynamic Engineering), *Buffalo, N. Y.* On Roller Mills.

JOSEPH POWELL, JR. (Civil Engineering), *Towanda, Pa.* On the Sewerage and Sewage Systems.

JOSEPH WARREN ROGERS, JR. (Dynamic Engineering), *Scarborough, N. Y.* On the Theory of the Dynamo-Electric Engine.

WALTER ALLEN SADD (Civil Engineering), *South Windsor.* On the Ventilation of Public Buildings.

WILLIAM GODFREY SAGE (Dynamic Engineering), *Chicago, Ill.* On Hydraulic Elevators.

RUSSELL SARGENT (Chemistry), *New Haven.* On the Incrustations of Boilers.

CLARENCE WELLINGTON SHELDON (Biology), *Brooklyn, N. Y.* On the Skull of the Cat.

JOHN PRENTICE TERRY (Dynamic Engineering), *Brooklyn, N. Y.* On Turbine Water Wheels.

CHESTER THORNE (Civil Engineering), *Millbrook, N. Y.* On the Improved Main Drainage System of Boston.

ELMORE ABRAM WILLETS (Select), Belmont, N. Y. On the Production of Crude Petroleum.

FRANKLIN ELDRED WORCESTER, A.B. (Dynamic Engineering), *Albany, N. Y.* On the Steam Indicator.

PRIZES.

CLASS OF 1884.

For excellence in *Civil Engineering*, the prize awarded to LAURENCE VINCENT BENÉT, *Washington, D. C.*

For excellence in *Dynamic Engineering*, the prize awarded to EDWIN MUSSER HERR, *Denver, Col.*, with honorable mention of CHARLES PERCIVAL FARQUAR, *York, Pa.*, and WM. WALLACE NICHOLS, *Manitou Springs, Col.*

For excellence in *German*, the prize divided between GEORGE WYCKOFF CUMMINS, *Vienna, N. J.*, and CHARLES PERCIVAL FARQUAR, *York, Pa.*

CLASS OF 1885.

For excellence in the *Mathematics of Junior Year*, the prize divided between JAMES ALWARD SEYMOUR, *Auburn, N. Y.*, and FREDERICK BREWSTER WHEELER, *Monroe*, with honorable mention of ROBERT NEILL BRACE, *Dobbs Ferry, N. Y.*, JOHN VENABLE HANNA, *Kansas City, Mo.*, and LOUIS MILTON SCHMIDT, *New Britain.*

CLASS OF 1886.

For excellence in *all the Studies of Freshmen Year*, the prize awarded to EMANUEL FRANK SELZ, *Chicago, Ill.*, with honorable mention of WILLIAM DAVID JOHNSON, *New Haven*, EDWIN FRANK MEYER, *Chicago, Ill*, GEORGE EUSTIS POTTS, *Philadelphia, Pa.*, and WILLIAM SANDERS TEVIS, *San Francisco, Cal.*

For excellence in *German*, the prize divided between EMANUEL FRANK SELZ and EDWIN FRANK MEYER, *Chicago, Ill.*

For excellence in *Mathematics*, the prize divided between HARRIE SHELDON LEONARD, *Washington, D. C.*, and WILLIAM SANDERS TEVIS, *San Francisco, Cal.*

For excellence in *Physics*, the prize awarded to THEODORE NEWTON CASE, *Hartford.*

For excellence in *Chemistry*, the prize awarded to WILLIAM SANDERS TEVIS, *San Francisco, Cal.*

For excellence in *Mechanical Drawing*, the prize awarded to FREDERICK WILLIAM DARLINGTON, *West Chester, Pa.*, with honorable mention of WILLIAM WALLACE ATTERBURY, *Detroit, Mich.*, and ROCKWELL AMASA WILLIAMS, *Canterbury.*

For excellence in *English Composition*, 1st Prizes: HENRY WILLIAM BLAKE, *New Haven;* CALVERT TOWNLEY, *Cincinnati, O.* 2d Prizes: FREDERICK WILLIAM DARLINGTON, *West Chester, Pa.;* ALEXANDER HARRISON DAVIS, *Watertown;* WILLIS BENJAMIN HERR, *Denver, Col.* 3d Prizes: WILLIAM WALLACE ATTERBURY, *Detroit, Mich.;* WILLIAM WASHINGTON GORDON, *Savannah, Ga.;* WILLIAM DAVID JOHNSON, *New Haven;* HARRIE SHELDON LEONARD, *Washington, D. C.;* HENRY HAYES WADSWORTH, *Glencoe. Minn.*

PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1884-85.

CALENDAR.

1884.		
18 Sept.	Thursday,	First Term begins.
22 Dec.	Monday,	First Term ends.
1885.		**Winter Vacation of two weeks.**
6 Jan.	Tuesday,	Second Term begins.
1 April,	Wednesday,	Spring Recess begins.
8 April,	Wednesday,	Spring Recess ends.
23 June,	Tuesday,	Meeting of Appointing Board.
23 June,	Tuesday,	Anniversary.
24 June,	Wednesday,	Commencement.
25, 26, 27 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of thirteen weeks.
22, 23 Sept.	Tues., Wedn.,	Examination for Admission.
24 Sept.	Thursday,	First Term begins.
24 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

CORPORATION.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

S EXCELLENCY THOMAS M. WALLER, M.A., NEW LONDON.
S HONOR GEORGE G. SUMNER, HARTFORD.
:V. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.
:V. GEORGE J. TILLOTSON, M.A., WETHERSFIELD.
:V. MYRON N. MORRIS, M.A., WEST HARTFORD.
)N. WILLIAM M. EVARTS, LL.D., NEW YORK CITY.
IEF JUSTICE MORRISON R. WAITE, LL.D., WASHINGTON, D. C.
:V. LAVALETTE PERRIN, D.D., TORRINGTON.
:V. SAMUEL G. WILLARD, M.A., COLCHESTER.
)N. HENRY B. HARRISON, M.A., NEW HAVEN.
:V. JOSEPH W. BACKUS, M.A., PLAINVILLE.
)N. FREDERICK J. KINGSBURY, M.A., WATERBURY.
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nningham Oliver,	*Pittsburgh, Pa.,*	138 College st.
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ɜnry Matthiessen,	*Cornwall, N. Y.*,	36 Elm st.
ɜeker,	*Chicago, Ill.*,	43 College st.
ınk Meyer,	*Chicago, Ill.*,	126 High st.
ırkins Miller,	*Utica, N. Y.*,	60 w.
ıite Patten,	*North Haven*,	119 Greene st.
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ɜderick Prentiss,	*Watertown, Wisc.*,	36 Elm st.
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nes Richmond,	*Providence, R. I.*,	43 College st.
ɜstwick Robbins,	*Lakeville*,	152 Grove st.
Ronalds,	*New York City*,	43 College st.
· Holley Rudd,	*Lakeville*,	389 Temple st.
stin,	*Omaha, Nebr.*,	159 York st.
Frank Selz,	*Chicago, Ill.*,	126 High st.
ıpland Shaw,	*Buffalo, N. Y.*,	63 Prospect st.
anders Tevis,	*San Francisco, Cal.*,	36 Elm st.
ɜalfe Thomas,	*New York City*,	134 College st.
ɜwnley,	*Cincinnati, O.*,	101 w.
ɜllok Devereux Townsend,	*Middletown*,	101 w.
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ward Warnock,	*Atlanta, Ga.*,	126 High st.
'illcox,	*Omaha, Nebr.*,	163 Temple st.
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ıghton Williams,	*Minneapolis, Minn.*,	389 Temple st.
ɜKnight Woods,	*New Haven*,	364 George st.

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William Greenhow Doane,	*Omaha, Nebr.,*	
John Ambrose Doolittle,	*New Haven,*	
Edward Warburton Durant,	*Stillwater, Minn.,*	
Isadore Dyer, Jr.,	*Galveston, Tex.,*	
Henry Hayes Ellis,	*Oxford, Me.,*	7
Charles Francis Emerson,	*Titusville, Pa.,*	1
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Raymond Thomson French,	*Seymour,*	
Charles Hunter Gardner,	*New Haven,*	7
Francis Frederic Georger,	*New York City,*	
Robert Fisher Gibson,	*York, Pa.,*	
Charles Joseph Goldmark,	*New York City,*	6
Wilfred Elizur Griggs,	*Waterbury,*	
George Conradt Ham,	*Washington Hollow, N. Y.,*	
Harry Leon Hamlin,	*Chicago, Ill.,*	11
Edgar Burton Harger,	*Oxford,*	16 1
William Lynde Harrison,	*New Haven,*	
Herbert Leopold Hart,	*Chicago, Ill.,*	
James Henry Hayden,	*New York City.*	55
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Leonard Abbot Jenkins,	*Dresden, Saxony,*	
Charles Sherman Jewett,	*Buffalo, N. Y.,*	1
John Edwin Judson,	*New Haven,*	14
Frederick Sheffield Kellogg,	*Utica, N. Y.,*	55
Charles Foster Kent,	*Palmyra, N. Y.,*	3
Grayson Guthrie Knapp,	*Auburn, N. Y.,*	3
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tewart Kulp,	*Wilkesbarre, Pa.,*	242 York st.
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Mansfield Smith,	*East Haven,*	East Haven
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l Robertson Tyler,	*Owensboro, Ky.,*	242 York st.
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Francis Timothy Smith,	*Simsbury*,	7 Pearl st.
Warren A. Spalding,	*New Haven*,	89 Church st.
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SUMMARY.

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SENIORS,	69
JUNIORS,	70
FRESHMEN,	81
SPECIAL,	10
TOTAL,	250

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction d researches in the mathematical, physical, and natural sciences, ith reference to the promotion and diffusion of science, and also the preparation of young men for such pursuits as require pecial proficiency in these departments of learning. It is one of e Departments of Yale College, like the law, medical, theologi-l, and art schools, having its separate funds, buildings, teachers, d regulations, but governed by the Corporation of Yale Col-ge, which appoints the professors and confers the degrees. It in part, analogous to the academic department, or classical col-ge, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other Colleges, and other persons alified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical l scientific, in less part linguistic and literary, for higher scien-c studies, or for various other occupations to which such train-g is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient ilding and a considerable endowment were given by Joseph E. effield, Esq., of New Haven, whose name, at the repeated uest of the Corporation of Yale College, was afterward ached to the foundation. Mr. Sheffield afterward frequently l munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national ant for the promotion of scientific education (under the con-essional *enactment of July*, 1862) was given to this department

of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the

Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor RICHARDS, in dynamical engineering.

Professor HASTINGS, in selected topics in physics, and guidance in laboratory work.

Professor Brush, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional *progress.*

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must not be less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid or a similar amount of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount and Commission; Proportion, Extraction of the Square and Cube Roots.

Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—Including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's, or Richards's, or Wentworth's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. *If the use of logarithms* is postponed in his preparation till Trigo-

nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the soultion of triangles. Finally in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1885, take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 25, 26, 27 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 22, 23 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1885 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 25, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a*) In Chemistry; (*b*.) In Civil Engineering;
(*c*.) In Dynamical (or Mechanical) Engineering;
(*d*.) In Agriculture; (*e*.) In Natural History;
(*f*.) In Biology preparatory to Medical Studies;
(*g*.) In studies preparatory to Mining and Metallurgy;
(*h*.) In select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons, in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working-drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following Courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry* — Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing* — Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working-drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology* — Dana's. *Botany. Zoölogy. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoölogy. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoölogy, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual: Laboratory Practice. *German. French.*

SECOND TERM—*Zoölogy*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoölogy*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoölogy*—Laboratory Practice; Recitations; Lectures. *Botany* — Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice, and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—Dana's. *French.*

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology. Geology*—Dana's. *Zoölogy*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Bright's History of England. *French. German.*

SECOND TERM — *Mineralogy* — Lectures. *Astronomy. Botany* — Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Bright's History, continued. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoölogy*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction in this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best

nethods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoölogy excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collection at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blow-pipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and

by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on page 37.

3. Doctor of Philosophy: The requirements for this degree are stated on page 35.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 24, 1885. The first term begins thirteen weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (*See Calendar, p. 20.*)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 23, 1885, and at or about the same time in the year 1886, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

APPENDIX

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1884, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JUNE, 1884.

1. Reduce $\frac{3}{4}$, $\frac{2}{5}$, $\frac{4}{9}$, and $\frac{5}{11}$ to the least common denominator.

2. (*a*) Divide $\frac{\frac{7}{8}}{\frac{3}{11}}$ of $12\frac{1}{2}$ by $\frac{\frac{1}{3}}{7\frac{1}{2}}$ of $8\frac{3}{4}$.

(*b*.) Divide .0003538709 by .007643 and explain the position of the decimal point.

3. In 80937864 square inches how many acres?

4. A merchant sold a piece of cloth for $24, and thereby lost 25 per cent.; what would he have gained had he sold it for $34?

5. A gentleman wishes to take $1,000 from the bank; for what sum must he give his note, payable in 5 months, at 6 per cent. discount?

6. Extract the square root of 10 to five decimal places.

7. Give the approximate value of the meter in inches; of the gram in grains; of the kilogram in pounds avoirdupois.

8. What is to be the depth of a box 12^m long and 8^m wide, in order to hold 2,500 hectoliters?

ARITHMETIC.

SEPTEMBER, 1884.

1. Find the greatest common divisor of 918 and 522.

2. Reduce $\frac{7\frac{1}{2} \text{ of } 5\frac{6}{15}}{2\frac{1}{14} + 3\frac{1}{6}}$ to its lowest terms and express the result decimally.

3. I invested one-half of my capital in bank stock, and the balance in railroad stock. I gained 11 per cent. on the bank stock, and lost $7\frac{1}{2}$ per cent. on the railroad stock, and my net gain was $175. How much was my capital?

4. A and B engage in trade with $500. A put in his stock for 5 months, and B put in his for 4 months. A gained $10, and B gained $12; what sum did each put in?

5. Extract the cube root of 1860867.

6. When it is 2h. 36m. A. M. at the Cape of Good Hope, in longitude 18° 24′ east, what is the time at Cape Horn, in longitude 67° 21′ west?

7. Give the metric measures of length and their equivalents in denominations in use.

8. In a field 200 meters long and 56 meters broad, how many acres?

GEOMETRY.

JUNE, 1884.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper: those for the first year's partial examination, the first part of it: those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.—*Plane Geometry.*

1. The bisectors of the three interior angles of a triangle meet in a point equally distant from the sides of the triangle.

2. The line drawn from the middle of one of the non-parallel sides of a trapezoid parallel to the parallel sides is equi-distant from them, equal in length to half their sum, and bisects the opposite side.

3. If from a point without a circle a secant and a tangent be drawn, the tangent is a mean proportional between the whole secant and the part without the circle.

4. (*a*) Define a geometric *locus.*

(*b*) If the base and vertical angle of a triangle be given; find the locus of the vertex.

5. If the apothegm of a regular hexagon is h, what is the area of the ring included between its inscribed and circumscribed circles?

II.—*Solid and Spherical Geometry.*

6. In a convex polyhedral angle the sum of the face angles is less than a circumference.

7. Similar polyhedrons are to each other as the cubes of their homologous edges.

8. The frustum of a cone of revolution whose altitude is 20 feet, and the diameters of its bases 12 feet and 8 feet respectively, is divided into two equal parts by a plane parallel to its bases. What is the altitude of each part?

9. Find the ratio of the surfaces, and the ratio of the volumes, of a cube and of the inscribed sphere.

10. In two polar triangles each side of the one is the supplement of the *opposite angle* of the other.

GEOMETRY.

SEPTEMBER, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Determine the symmetrical figure of a trapezium with respect to a point lying without, and with respect to an axis cutting the trapezium.

2. Of all triangles having the same base and equal perimeters, that which is isosceles is the maximum.

3. To construct a triangle which shall be equal in area to a given polygon.

4. Construct an angle of 60°, one of 30°, one of 120°, one of 45°, and one of 135°.

5. If a line intersect a plane, it makes a less angle with its projection than with any other line in the plane passing through the point of intersection.

6. The surface of a cone of revolution is 540 square inches; what is the surface of a similar cone whose volume is 8 times as great?

7. Define *equal spherical triangles* and *symmetrical spherical triangles*. Show that the latter cannot be made to coincide except in one case.

8. Find the surface and volume of a sphere whose radius is 10 inches; also find the area of a spherical triangle on this sphere, the angles of the triangle being 80°, 85°, and 100° respectively.

ALGEBRA.

JUNE, 1884.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper: those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject and to what extent.

I.

1. Find the factors of $x^2 + 8x + 16$; $x^3 + 8$; $x^4 - 16$.

2. Solve the equation $\frac{ab+x}{b^2} - \frac{b^2-x}{a^2b} = \frac{x-b}{a^2} - \frac{ab-x}{b^2}$.

3. Given $\frac{a}{x}+\frac{b}{y}=m$ and $\frac{b}{x}-\frac{a}{y}=n$, to find x and y.

4. (*a*) Expand $(x+2)^4$. (*b*) Simplify $\sqrt[3]{a^3+3a^2b+3ab^2+b^3}$.

5. Simplify (*a*) $\sqrt[4]{16a^{12}b^8c^4}$. (*b*). $\sqrt[6]{\frac{64x^{18}}{729x^6}}$.

(*c*). $(-1)^{2n}$. (*d*). $\sqrt[3]{81}-\sqrt[3]{192}$.

II.

6. Solve the equation $8x^2-7x+34=0$ and verify your solution.

7. Given $x-y=7$ and $x^2+xy+y^2=13$, to find x and y.

8. Given $\frac{\sqrt{7x^2+4}+2\sqrt{3x-1}}{\sqrt{7x^2+4}-2\sqrt{3x-1}}=7$, to find x.

9. Insert two geometrical means between a and b.

10. What sum of money (s) must be set apart annually, and put at compound interest as a sinking fund, to pay a debt of a dollars in n years, if the interest on one dollar for one year is r?

ALGEBRA.

SEPTEMBER, 1884.

[State what text-book you have studied on the subject and to what extent.]

1. Given $\frac{x-y+1}{x-y-1}=a$, and $\frac{x+y+1}{x+y-1}=b$, to find x and y.

2. If $\frac{a_1}{b_1}=\frac{a_2}{b_2}=\frac{a_3}{b_3}=r$, show (1) that $r=\frac{a_1+a_2+a_3}{b_1+b_2+b_3}$.

(2) that $r=\sqrt[2]{\frac{a_1^2+a_2^2+a_3^2}{b_1^2+b_2^2+b_3^2}}$.

3. Expand $(x-2a)^5$ by the binomial formula.

4. Simplify (1.) $\frac{x^{\frac{2}{3}}-y^{\frac{2}{3}}}{x^{\frac{1}{3}}-y^{\frac{1}{3}}}$. (2.) $\sqrt{8}+\sqrt{50}-\sqrt{18}$.

(3.) $\sqrt[3]{2}\times\sqrt[2]{\frac{1}{8}}\times\sqrt[3]{3}$. (4.) $(\sqrt{-1})^3$.

5. Find the square root of $28+10\sqrt{3}$, in its simplest form.

6. Form an equation whose roots shall be 3 and -5.

7. Solve the equation $6x^2+x-12=0$ and resolve its first member into its factors.

8. The number of permutations of n things 3 together is 6 times the number of combinations 4 together, find n.

9. Develop $\frac{1+x}{2+3x}$ into a series by the method of indeterminate coefficients (four terms of the series will suffice).

10. (1) What is the logarithm of zero in a system whose base is greater than one? Demonstrate your answer.

(2.) Transform $\log \sqrt[2]{\frac{a^3b^4c^5}{de}}$ into a form well adapted to computation.

TRIGONOMETRY.

JUNE, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Define the *radian* or unit of circular measure of an angle. Express an angle of 0.5 in degrees.

2. Deduce a formula for expressing $\sin \alpha$ in terms of $\tan \alpha$.

3. Assuming the fundamental formula for the cosine of the sum of two angles show that

$$\cos \tfrac{1}{2}\alpha = \sqrt{\frac{1 + \cos \alpha}{2}}.$$

4. Given (*a*) $\tan x + \cot x = 10$ to find $\tan x$.

(*b*) $\sec x + \tan x = \frac{1}{2}$ to find $\tan x$.

How many values of x are there between 0 and 2π that will satisfy these equations respectively?

5. Write the usual formulæ for solving the different cases of oblique plane triangles, and explain carefully your notation.

6. Having given three sides of a triangle $a = 701.22$ feet, $b = 438.26$ feet, $c = 613.57$ feet to find the three angles and the area of the triangle. Check your calculation of the angles, and show how you might check that of the area.

TRIGONOMETRY.

SEPTEMBER, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Express 60° in *radians* or units of circular measure.

2. Find the functions of 930°.

3. Name the angles between 0° and 720° whose tangent is 1; also those whose tangent is -1.

4. Assuming the usual data deduce the following formulæ.

(1) $\tan 2a = \frac{2 \tan a}{1 - \tan^2 a}$.

(2) $\sin a + \sin b = 2 \sin \frac{1}{2}(a + b) \cos \frac{1}{2}(a - b)$.

5. Given $\tan\left(\frac{\pi}{4} - \theta\right) + \cos\left(\frac{\pi}{4} - \theta\right) = 4$, to find $\tan \theta$.

6. Given two sides of a triangle, $b = 2956.2$, $c = 9090.8$ and the included angle $A = 98° 29'.6$ to find the remaining parts of the triangle.

ENGLISH GRAMMAR.

JUNE, 1884.

[State what text-book you have used.]

I. Define noun, pronoun, interjection and conjunction.

II. Inflect throughout the personal pronouns.

III. State the difference between the strong (or old) and the weak (or new) conjugation of the verb, and give three illustrative examples of each.

IV. Parse the following sentence.

The best men whom he had seen were opposed to the views that he advocated.

LATIN.

JUNE, 1884.

I. Translate *as literally as possible:*

a. Quod si veteris *contumeliae* oblivisci vellet, num etiam recentium *injuriarum*, quod, eo invito, iter per provinciam per vim tentassent, quod Aeduos, quod Ambarros, quod Allobrogas vexassent, memoriam deponere posse? Quod sua victoria tam insolenter gloriarentur, quodque tam diu se impune injurias tulisse admirarentur, eodem pertinere.

b. Hanc si nostri transirent, hostes exspectabant; nostri autem, si ab illis initium *transeundi* fieret, ut impeditos aggrederentur, parati in armis erant. Interim proelio equestri inter duas acies contendebatur. Ubi neutri transeundi initium faciunt, secundiore equitum *proelio* nostris, Cassar suos in castra *reduxit.*

c. Nostri primo integris viribus fortiter ***repugnare***, neque ullum frustra telum ex loco superiore mittere; ut quaeque pars castrorum *nudata* defensoribus premi videbatur, eo occurrere et auxilium ferre, sed hoc superari, quod diuturnitate pugnae hostes defessi proelio excedebant, alii integris viribus succedebant.

d. At hostes ubi primum nostros equites conspexerunt, quorum erat quinque millium numerus, quum ipsi non amplius octingentos equites haberent, quod ii, qui ***frumentandi*** causa ierant trans Mosam, nondum redierant, nihil timentibus nostris, quod legati eorum paulo ante a Caesare discesserant atque is dies *induciis* erat ab his petitus, impetu facto celeriter nostros perturbaverunt.

e. Mittuntur ad Caesarem confestim ab Cicerone litterae, magnis propositis praemiis si ***pertulissent***. Obsessis omnibus viis missi intercipiuntur. Noctu ex materia, quam munitionis causa comportaverant, turres admodum centum et viginti excitantur incredibili celeritate: quae deesse ***operi*** videbantur, perficiuntur.

f. Ubii, qui ante obsides dederant atque in deditionem venerant, purgandi *sui* causa ad eum legatos mittunt, qui doceant neque auxilia ex sua civitate in Treviros missa, neque ab se fidem laesam: petunt atque orant, ut sibi parcat, ne communi *odio* Germanorum innocentes pro nocentibus poenas pendant, si amplius *obsidum* velit, dare pollicentur.

II.—1. Decline *iter* (2), *veteris* (1), *vim* (3).

2. Compare *secundiore* (11), ***fortiter*** (13), ***primo*** (13).

3. Write the synopsis, active and passive, of ***conspexerunt*** (19).

4. Parse in full each word in the first two lines of passage *c*.

5. Give the principal parts of the following: ***oblivisci*** (1), *vellet* (1), *deponere* (4), *premi* (15), ***excedebant*** (17), ***petitus*** (24), *obsessis* (27), *deesse* (30), *perficiuntur* (31), ***doceant*** (34), ***laesam*** (35), *parcat* (35), *pendant* (37).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

LATIN.

SEPTEMBER, 1884.

I. Translate as literally as possible—

a. Ubi per exploratores Caesar certior factus est, tres jam copiarum partes Helvetios id *flumen* transduxisse, quartum vero partem citra flumen Ararim *reliquam* esse, de tertia vigilia cum legionibus tribus e castris profectus ad eam partem pervenit, quae nondum flumen transierat.

b. Interim omnis ex fuga Suessionum multitudo in oppidum proxima *nocte* convenit. Celeriter vineis ad oppidum actis, aggere jacto, turribusque constitutis, magnitudine operum, quae neque viderant ante Galli neque audierant, et celeritate Romanorum *permoti*, legatos ad Caesarem de deditione mittunt, petentibus Remis ut conservarentur impetrant.

c. Itaque quum intelligeret omnes fere Gallos novis *rebus* studere et ad bellum mobiliter celeriterque excitari, omnes autem homines natura libertati studere et conditionem servitutis odisse, priusquam plures civitates conspirarent, partiendum *sibi* ac latius distribuendum exercitum putavit.

d. Quod ubi Caesar animadvertit, naves longas, quarum et species erat *barbaris* inusitatior et *motus* ad usum expeditior, paulum removeri ab onerariis navibus et remis incitari et ad latus apertum hostium constitui, atque inde fundis, sagittis, tormentis, hostes propelli ac submoveri jussit: quae res magno usui *nostris* fuit.

e. Ex his omnibus longe sunt humanissimi, qui Cantium incoluut, quae regio est maritima omnis, neque multum a Gallica differunt *consuetudine.* Interiores plerique frumenta non serunt, sed lacte et *carne* vivunt pellibusque sunt vestiti.

f. Erat, ut supra demonstravimus, manus certa nulla, non oppidum, non praesidium, quod se *armis* defenderet, sed omnes in partes dispersa *multitudo.* Ubi cuique aut vallis abdita aut locus silvestris aut palus impedita spem praesidii aut salutis aliquam offerebat, consederat.

II.—1. Decline *certior* (1), *aggere* (8), *turribus* (8).

2. Compare *mobiliter* (13), *latius* (16), *apertum* (20).

3. Write the synopsis, active and passive, of *propelli* (21), or *removeri* (19).

4. Parse in full each word in the last two lines of passage c.

5. Give the principal parts of the following: *profectus* (4), *jacto* (8), *mittunt* (11), *studere* (13), *odisse* (15), *animadvertit* (17), *incolunt* (24), *differunt* (25), *vivunt* (26), *serunt* (26), *dispersa* (29), *consederat* (31).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

LATIN EXERCISE.

JUNE, 1884.

1. Despatches[1] are immediately[2] sent[3] by Cicero[4] to[5] Caesar.

2. Cicero immediately sends despatches to Caesar.

3. The despatches were not carried-through[6], as all the roads were occupied. (Use the ablative absolute.)

4. The messengers[7] are captured[8] *in consequence of the occupation of the woods* (ablative absolute).

5. If the roads had not been occupied the messengers would not have been captured (ablative absolute).

6. Since the enemy had occupied the roads, the messengers were unable to carry-through the despatches.

7. The messengers say they will carry through the despatches.

8. Rewrite sentence seventh so as to illustrate direct statement.

9. The messengers formed the plan of *carrying through the despatches.* (Translate the italicized words in two ways.)

10. The messengers, who *through the occupation of the woods* (abl. absolute), were unable to carry through the despatches were captured by the enemy (plural).

[1] litterae. [4] Cicero. [7] missus.
[2] confestim. [5] ad. [8] intercipere.
[3] mittere. [6] perferre.

LATIN EXERCISE.

SEPTEMBER, 1884.

1. The Helvetians[1] lead[2] (their) forces across[3] the river[3].

2. The forces of the Helvetians are being led across the river.

3. Caesar was informed[4] (that) the Helvetians were leading their forces across the river.

4. Caesar was informed (that) the Helvetians had led their forces across the river.

5. Three-fourths (i. e. parts[4]) of the forces were led across the river by the Helvetians.

6. Three-fourths of the forces having been led across the river; Caesar cut to pieces[6] the fourth[7] part.

7. The fourth part which had not yet[8] crossed[2] the river was cut to pieces by Caesar.

8. Caesar departs[9] with three legions[10] *to cut to pieces a part of the Helvetians.* (Translate the italicized words in two ways.)

9. Caesar says he has cut to pieces the fourth part of the forces.

10. Caesar said he had cut to pieces the fourth part of the forces.

[1] Helvetius. [2] transducere. [3] flumen. [4] certior fieri. [5] pars. [6] concidere. [7] quartus. [8] nondum. [9] proficisci. [10] legio.

GEOGRAPHY.

JUNE, 1884.

1. Bound the State of Pennsylvania; state the names of its chief cities and tell how they are situated; what are the principal rivers in the State and on its borders?

2. Where does the Missouri River rise; describe the direction of its course; what States and territories does it pass through or touch from its head to its mouth?

3. Name the States and countries in their order, which touch the Gulf of Mexico, beginning on its northeast.

4. Bound Brazil; give the names of two cities in it and tell how they are situated; what are its chief rivers and in what part of the country do they run?

5. Bound China; give the names of three of its cities and tell how they are situated; tell what are its chief rivers and where they run.

6. Where are the following islands: Azores; Bermudas; Phillipine; Disco; St. Helena?

GEOGRAPHY.

SEPTEMBER, 1884.

1. Bound the State of Kentucky; give the names of its chief cities, and tell how they are situated; what are the principal rivers in the State and on its borders?

2. Where is the river Danube; where does it rise, what direction does it run, where does it empty and what countries does it touch in its course?

3. What countries surround the Baltic Sea; tell which direction each lies from the sea; where and what is the entrance to the sea.

4. Beginning east, name in their order the States and territories of the United States which touch Mexico; name one city in each of these States and territories.

5. Bound Siberia; to what government does it belong; what mountains on its western boundary; name two rivers in it which empty into the Arctic ocean; what peninsula in its eastern part?

6. Where are the following cities: Havana; Florence; Winnipeg; Atlanta; Acapulco?

HISTORY OF THE UNITED STATES.

JUNE, 1884.

I. Give the dates of the battle of Great Meadows, the Hartford convention, the emancipation of the slaves, Missouri Compromise and state who was President in 1820, 1830, 1840, 1850.

II. Give an account of the formation of the colony of Maryland.

III. How and by what nation was Manhattan Island first settled, and how did it come into the possession of England?

IV. Describe the Stamp Act. When was it passed and when and why repealed?

V. Relate the causes of the War of 1812 and state by what treaty it was ended.

VI. What was the Kansas-Nebraska bill and when was it passed?

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1884.

I. Give the dates of the Albany convention, the battle of Tippecanoe, Dorr's Rebellion, the attack on Fort Sumter and state who was president in 1812, 1822, 1832, 1842.

II. Describe the planting of the colony of Pennsylvania.

III. Give an account of the Pequod War.

IV. When and why was the Boston Port Bill passed and what did it provide?

V. Give an account of Shays' Rebellion.

VI. What treaty ended the Mexican War and what were its provisions?

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TWENTIETH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1885-86.

206.

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1886.

STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

His Excellency HENRY B. HARRISON, New Haven.

Lieutenant-Governor.

His Honor LORRIN A. COOKE, Barkhamsted.

State Senators.

Hon. JOSEPH W. ALSOP, Middletown.

___ _____ _____ _____

___ _____ _____ _____

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The Board of Visitors have the honor to transmit herewith the Annual Statement of the Governing Board of the Sheffield Scientific School.

The Agricultural College Fund amounts to $135,000. Of this amount, $128,925 is invested in bonds and mortgages bearing interest at the rate of not less than five per cent. per annum, the minimum prescribed by the Act of Congress creating the fund. There is in the hands of the Treasurer of the State $6,075 on which the State pays interest at the rate above mentioned. The interest actually received from invested funds for the year ending December 31st, 1885, was $6,386.24.

The sum thus received and paid to the School is wholly devoted to scholarships, which are distributed among the counties of the State in proportion to their population. Thus to a considerable body of promising young men the State extends ample and thorough instruction in "Agriculture and the Mechanic Arts." The number of applicants largely exceeds the number of scholarships which the fund can provide.

To the State as thus connected with the School, great and essential and constantly increasing benefits accrue. The

interest received constitutes about one-eighth of the amount expended by the officers of the School. To every dollar given are added seven,—immeasurably increasing the utility and power of the sum contributed. Moreover, here original research is instituted and carried to its practical applications. In the broadest and best sense, scientific training is furnished and at the same time the basis of technical skill is laid. In sight of our busy communities and in active sympathy and coöperation with them is a prosperous training school for mechanics, manufacturers and farmers. It follows that those who have held scholarships have been the recipients of thorough and stimulating instruction, to the infinite advantage of the commonwealth. It is known that most of these beneficiaries are now engaged in mechanical occupations or farming in this State, and are giving intelligent impulse and direction to our industrial energies.

The State could well afford to extend such education, to all who desire to obtain it.

HENRY B. HARRISON,
Chairman.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their twentieth Annual Statement, the Governing oard of the Sheffield Scientific School have again the gratifica- on of reporting the continued prosperity of the institution, so r as that is indicated by the increase of attendance. The whole ımber of students on their rolls is slightly larger than ever efore. More than that, the entering class of this year is the rgest that has ever been admitted. It is satisfactory to feel ıat the work done by the School is appreciated especially in this ate, from which the number of students regularly increases from ar to year. At the same time it is easy to overrate the import- ıce of this fact. The excellence of an institution can never be sted by the numbers in attendance, nor can the growth in that rection of any scientific school long compensate for any failure ı its part to keep up with the demand for full instruction in the ırious departments allied to the practical concerns of life. As erefore of special importance in connection with the manufac- ring interests of this State, the Governing Board call attention ›th to what has been done during the past year and what still eds to be done in the departments of Physics and of Dynam- al or

Mechanical Engineering.

The small Bigelow steam engine, a gift acknowledged in a evious report, has been set at work in the basement of North neffield Hall in connection with a dynamo-electric machine belong-

ing to the department of Physics. The engine is supplied with steam from a new boiler, bought last year on liberal terms of Messrs. H. B. Bigelow & Co.

It is intended that this apparatus shall be used for experimental purposes, to afford graduate students opportunity to conduct original investigations, and that the room in which the engine is placed shall form the nucleus of an Engineering Laboratory, the equipment of which can be improved and increased as rapidly as the means of the School or liberality of donors to this object will permit. It would be of great advantage to the department of engineering, and would increase the good reputation of the School to have a thoroughly well equipped Engineering Laboratory in which investigations which would add to the stock of useful knowledge in this province of science could be carried on to advantage. The increased facilities thus offered would induce students to take the graduate course and would attract special students.

Among the gifts to this department, not before reported, are the following:

A gauge for measuring the draught force of chimneys—from the Hartford Steam Boiler Inspection and Insurance Co.

A 2-inch swivel vise with swivel jaw—from the Bagley & Sewall Co., Watertown, N. Y.

An old McNaught steam engine indicator, in excellent condition—from the Colt's Pat. Fire Arms Mfg. Co., Hartford.

A model of an ingenious friction clutch pulley—from the inventor, Mr. Albert B. Bean, New Haven.

A No. 1 Gaskell steam pump, highly finished and nickel plated, with portions cut away to exhibit the interior—from the Holly Manufg. Co., Lockport, N. Y.

A set of standard end measure gauges, one inch, one-half inch, and one centimeter long—from the Pratt & Whitney Co., Hartford. These standards are of extreme accuracy and are very valuable.

The same firm have also, during the past year, given to the department complete sets of blue prints of the details of machinery they are engaged in making. There are about 40 sheets of these working drawings mounted on heavy pasteboard and varnished, and they form an important addition to the collection of working drawings which are used in giving instruction in machine designing. Contributions of the kind enumerated above are urgently

solicited from the graduates of the School who are now in the practice of their profession, and from manufacturers of machinery and mechanical appliances. The models and drawings are always open to the examination of the students and are studied by a large number of young men who are being educated to fill positions as mechanical engineers.

The opportunity must be taken here to acknowledge the kindness of the officers and contractors of the New Haven Manufacturing Co. in permitting the students of Mechanical Engineering to visit their shops daily. They have afforded every facility to the student for studying the operations in shop practice, and for examining and sketching the details of finished machinery and machines in process of construction.

The New York, New Haven and Hartford R. R. Co. have also kindly given permission to the students to visit frequently the extensive construction and repair shops of the Road. These opportunities are taken advantage of to give the students familiarity with a variety of machinery of excellent quality.

A course of lectures on the theory of electricity and its applications will be open to students in the department of Engineering, and these lectures can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

Attention is called to a want which is much felt in this department. The valuable unbound engineering periodicals which are now very numerous and are accumulating rapidly in the library, are necessarily accessible only with difficulty in their present condition, but could be made available for frequent reference if bound. A fund is much needed to meet the expense of binding these periodicals, for they contain records of the most recent developments in the sciences to which they relate, and a familiarity with their contents is important to the instructors and the students.

Department of Physics.

The principal addition to the apparatus during the past year is the dynamo-electrical machine from Dr. Edelmann's shops in Munich. It is driven by a four horse-power engine, presented by Mr. Frank Bigelow to the department of Dynamical Engineering, and is contained with the engine in one of the rooms belonging to that department. The machine is admirably constructed, and of quite sufficient capacity to meet all our wants. Arrangements for

virtually altering the winding of the machine not only renders it peculiarly convenient for a wide range of uses but also adapt it for experimental study. The limits of its power are eleven Ampères with an electro-motive force of eighty volts and twenty-two Ampères with forty volts. Higher values than these, although quite attainable with the liberal engine-power at our command, are attended with dangerous heating of the machine if long continued.

The dynamo is connected by well insulated and very thick copper conductors in the lecture room of the department, as also with the large lecture room. In the engine room, properly connected with the circuit, are a voltmeter and an am-meter of the Charpentier form. An electric bell in an independent circuit from the lecture room admits of easy communication with the attendant in the engine room.

Other additions to the apparatus are as follows:

A tangent galvanometer with coarse and fine windings. This was made by rewinding a galvanometer from a German workshop so as to render the computation of its contents possible, and also changing the needle to one of less than a tenth of the mass of that provided by the maker. The pointers, of fine aluminium wire, now move over a mirror bottom of the compass-box.

A heliostat having two mirrors, of which one only moves by clock-work; it directs a beam of light never less than four inches in diameter whatever the position of the sun above the horizon.

A clock with a compensating seconds pendulum provided with a novel arrangement for closing an electric circuit at every swing so that the energy taken from the clock is extremely minute, while at the same time the contact is perfectly satisfactory even with very large currents. As is well known to those who have attempted to use mercury contacts for intense currents the performance is unusual.

A comparator with microscopes, which admits, however, of comparing lengths to a moderate degree of accuracy only.

A meter-scale of bronze for use as a secondary standard of length.

An Attwood's machine. This, instead of having an independent pendulum and clock-work, is introduced at will into the circuit of the standard clock which liberates the weights and sounds the successive seconds.

An apparatus for studying color sensations by Maxwell's method, with a large number of discs.

The only changes during the year in the undergraduate department are those accompanying a change in text-books used, Stewart's Physics being found wholly inadequate to the needs of the class. Everett's Deschanel has been adopted for the present year. After the first of January, 1886, however, an optional course in electricity, adapted to seniors or graduates who have pursued mathematical courses, is to commence and extend through the year. It will consist primarily of two lectures a week interrupted occasionally by examinations on the work gone over. In addition to this a small number will have an opportunity for practical work in the physical laboratory. Whatever may be the demand for opportunities of this kind the facilities for satisfying them are narrowly restricted by insufficient room. It is impossible for the School, with the facilities at present at its command, to accommodate students who seek to pursue higher courses of study in a subject which is now attracting the attention of constantly increasing numbers: and it is a matter of first importance to the prosperity of the School that its deficiencies in these respects should be remedied as early as possible.

Necessity of Increased Endowments.

The statements in regard to the courses in Physics and Mechanical Engineering points very clearly to the necessity of more liberal endowments, if the School is to maintain the position it has so honorably won and hitherto firmly held. The studies are optional with certain limitations. This is in accordance with the tendency of the best modern educational methods; and indeed upon the maintenance of it the success of the institution depends. But optional courses are necessarily very expensive. They involve the procuring of a large number of instructors, some of whom must be and all of whom ought to be specialists. They involve also the constant supply of educational apparatus to carry on the higher work which is demanded by and for the better students. The resources of the institution have been steadily taxed to the utmost to meet both of these demands: and the Governing Board have constantly to undergo the mortification of being compelled to refuse students the privilege of pursuing certain branches of study, because they have not the means at their command to pay additional and competent instructors or to equip those on hand with the *proper facilities* for carrying on their work. Yet

they feel confident that everything which can be done with their present limited resources is done. The income from all sources of the School is about sixty thousand dollars a year. Of this, about fifty-five thousand is applied to the payment of instructors, leaving the scant sum of about five thousand dollars for all the other expenses, such as lights, fuel, insurance, care of buildings, repairs, payment of janitors, and other details connected with administration. It ought likewise to be added that the pay of the professors is lower in this department than in any of the endowed departments of the University; and that many of them have refused positions in other institutions, and in some instances in other callings in life, which would have yielded salaries far higher than they receive here. It can hardly be expected, however, nor is it right to expect, that men will forever continue to sacrifice their own personal prospects for the sake of a public institution, no matter how profoundly they may be interested in its success, and the graduates and friends of the School should see that they are placed under no such necessity.

Zoological Collections.

A. E. Verrill, Curator; K. J. Bush and C. E. Bush, Assistants.

The most important additions to the collections, as during several years past, have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the deep sea off our coast. During the past season the dredgings were carried on in the region of the Gulf Stream, from off Georgia to Newfoundland, and from shallow water to 2620 fathoms, by means of the steamer Albatross, Lieut. Z. L. Tanner commanding. The Grand Bank of Newfoundland was also extensively explored. The party was organized nearly as in 1883. Very large collections were made, and the larger part of the Invertebrata were sent here for identification and description, as in previous years.

The curator has published during the year in the American Journal of Science, and in the Annual Report of the Fish Commission accounts of these and previous explorations. He has also published the third descriptive catalogue of the deep-sea Mollusca, illustrated by several plates, in the Transactions of the Connecticut Academy, vol. vi. In these papers numerous species are added to the fauna, a large part of them new.

Professor S. I. Smith has taken charge of the Crustacea, and has published in the Proceedings of the National Museum, two papers on the new Decapod Crustacea dredged by the Albatross, mostly in 1884, and one on the Penæidæ. He has also prepared for the Annual Report of the U. S. Fish Commission, a detailed report on the Decapod Crustacea of 1884, with numerous plates.

Mr. J. H. Emerton has published a paper on the New England spiders of the family Lycosidæ in the Transactions of the Connecticut Academy, with four plates.

Miss K. J. Bush has continued the work of cataloguing and labeling the collections of shells, etc., dredged by the Fish Commission. She has also published in the Transactions of the Connecticut Academy, vol. vi, a descriptive Catalogue of the shallow water shells, new to the region, dredged by the Albatross near Cape Hatteras in 1883 and 1884. This includes a considerable number of new species and is illustrated by a plate.

Miss C. E. Bush has also been employed as an assistant on the collections of Invertebrates in the museum.

Numerous private collections that have been deposited in the museum by the curator during the past twenty years, have recently been purchased by the trustees of the museum. Among these are the large and fine series of shells, corals and echinoderms, from the Gulf of California, including the original types of numerous new species formerly described by the curator; valuable collections of corals from the East Indies and Pacific Ocean; large series of the marine invertebrates of New England, collected prior to 1873; a collection of New England birds and mammals, etc.

In addition to the collections dredged by the U. S. Fish Commission the following have been received:

J. K. Payne, Knoxville, Tenn. Collection of Unionidæ.

J. F. Whiteaves, Ottawa, Canada. Marine invertebrates from northern Labrador.

H. G. Fitz, New York. Several good, large, fresh examples of the southern *Mellita testudinata*, and rare shells from Long Island Sound, near Huntington, L. I.

Prof. J. S. Newberry. Sponge (*Verongia*) from Florida.

Dr. W. O. Ayres. Shells from the basin of Lake Lahontan.

B. H. Wright, De Land, Florida. Fresh-water Phyllopod Crustacea, in alcohol.

Dr. George Bauer, Peabody Museum. Two salamanders from *Europe*.

R. Ellsworth Call, Moline, Ill. Collection of Unionidæ from the Mississippi River; collection of Unionidæ and fresh water univalves from Tennessee and Alabama. By purchase.

Geo. E. Verrill, S. S. S., 1885. Birds' skins and eggs from Grand Manan, N. B.; mounted birds from New Haven.

Mrs. R. W. Summers, San Luis Obispo, Cal. Echinoderms and barnacles.

J. B. Hatcher, S. S. S. 1884. Lizard from Phillips Co., Kansas.

A. Herman. Bald eagle from Orange. Purchased.

A. E. Verrill. Albino flying squirrel from New Haven.

Mr. Gardiner. Fish (*Merlucius albidus*), from Short Beach.

A. E. Verrill. Land Shells from New Haven.

C. Hartt Merriam, M.D. Invertebrates from Labrador.

States Represented in the School.

The following table shows the States and Countries from which come the students whose names appear on the catalogue during the current year, and the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	3	--	3	1	7
2. Colorado	1	2	1	3	--	7
3. Connecticut	14	23	24	38	4	103
4. District of Columbia	1	1	--	1	1	4
5. Georgia	--	1	--	--	--	1
6. Illinois	--	5	6	9	--	20
7. Indiana	--	--	3	--	--	3
8. Kentucky	--	1	--	1	--	2
9. Louisiana	--	--	--	1	--	1
10. Massachusetts	--	--	2	1	--	3
11. Michigan	--	1	1	1	--	3
12. Minnesota	--	4	1	--	--	5
13. Missouri	--	2	--	--	--	3
14. Nebraska	--	2	1	1	--	4
15. New Jersey	1	2	1	--	1	5
16. New York	5	8	14	17	--	44
17. Ohio	--	3	4	5	1	13
18. Pennsylvania	--	4	6	4	--	14
19. Rhode Island	--	1	--	4	--	5
20. Texas	--	1	1	--	--	2
21. Virginia	1	--	--	1	--	2
22. Wisconsin	--	--	--	--	1	1
23. China	1	--	--	--	--	1
24. Japan	--	--	--	1	--	1
25. Sandwich Islands	--	--	--	2	--	2
26. Saxony, Germany	--	--	--	--	--	1
Total	24	64	66	93	9	256

To a certain extent these statistics are deceptive. Connecticut has always a number added to what belongs to it legitimately, from the fact that families come here from other States and take up a temporary residence for the sake of educating their children. Graduate students also frequently change their residences to New Haven.

Public Lectures.

The annual course of lectures to mechanics and others was given during the second term of the Academic year, 1884-85. The lectures and their subjects are indicated in the annexed programme:

I. Thursday, Feb. 12.—Norway and the Midnight Sun. Rev. Dr. C. C. Tiffany.
II. Tuesday, " 17.—Science and the Supernatural. Prof. Du Bois.
III. Thursday, " 19.—The Present Commercial Crisis. Mr. A. T. Hadley.
IV. Tuesday, " 24.—The Asiatic Cholera. Prof. Brewer.
V. Thursday, " 26.—The Sensation of Color. Prof. Hastings.
VI. Tuesday, Mar. 3.—Cobwebs. Mr. J. H. Emerton.
VII. Thursday, " 5.—Lafayette. Prof. A. M. Wheeler.
VIII. Tuesday, " 10.—The Patent Law of the U. S. Prof. Robinson.
IX. Thursday, " 12.—Commemoration of the Birthday of Bishop Berkeley. President Porter.
X. Tuesday, " 17.—The Surface Life of the Gulf Stream. Prof. Verrill.
XI. Thursday, " 19.—Map Projection. Prof. Phillips.
XII. Tuesday, " 24.—Apples. Prof. Daniel C. Eaton.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1884–85.

The order and subjects of the Lectures were as follows:

I. Friday, Feb. 27.—Strategy and Grand Tactics. 1st Lieut. Eugene J. Spencer, U. S. Engineers.
II. Monday, Mar. 2.—Logistics. 1st Lieut. James L. Lusk, U. S. Engineers.
III. Friday, " 6.—Small Arms and their influence on Tactics. 1st Lieut. Harry F. Hodges, U. S. Engineers.
IV. Monday, " 9.—Artillery. 1st Lieut. Graham D. Fitch, U. S. Engineers.
V. Friday, " 13.—Fortification. Capt. F. A. Mahan, U. S. Engineers.
VI. Monday, " 16.—Sea Coast Defense. General H. L. Abbot, U. S. Engineers.

ANNIVERSARY.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 23, 1885. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. The names in the first list are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

CIVIL ENGINEERS. (2.)

SAMUEL EBEN BARNEY, Ph.B., *New Haven.* Notes on the Construction of Railway Road-bed and Track.

GEORGE LEVERETT WILSON, Ph.B., *St. Paul, Minn.* On the Construction of the Conduit for the St. Paul Water-Works.

BACHELORS OF PHILOSOPHY. (70.)

*PAUL DAILY BERNARD (Select), *Brooklyn, N. Y.* On the History of the Prologue and Epilogue in the English Drama.

ROBERT NEILL BRACE (Dynamic Engineering), *Dobbs Ferry, N. Y.* On the New Croton Aqueduct.

MERRITT MEAD CLARK (Select), *Bedford, N. Y.* On the Physical Relations of Forests to the Prosperity of a Country.

*WALLACE SHERMAN CLARK (Dynamic Engineering), *Brooklyn, N. Y.* On the New Cruisers of the United States Navy.

IRVING COOK GLADWIN (Select), *Sherburne, N. Y.* On the History of English Hexameter Verse.

*JOHN VENABLE HANNA (Civil Engineering), *Kansas City, Mo.* On Railway Location.

*PERCY JACKSON (Chemistry), *Belleville, N. J.* On Pectin Bodies.

HARRY D. KOHN (Select), *Chicago, Ill.* On the History of the English Sonnet.

ALEXANDER LAMBERT, B.A. (Biology), *New York City.* On the Question whether the Liver possesses the Power of Converting Peptones into Carbohydrate Matter.

*JAMES JACOB MORGAN (Chemistry), *New Haven.* On the Determination of Lead as Sulphide.

*HARRY MCMAHON PAINTER, B.A. (Biology), *West Haven.* On the Influence of Various Therapeutic and Toxic Substances on the Amylolytic Action of Saliva.

DANIEL TUTHILL PRATT (Select), *Elmira, N. Y.* On the Development of the Liberty of the Press.

*SIDNEY ARMOUR REEVE (Dynamic Engineering), *Dayton, O.* On the Fireless Locomotive, with a Design for a Street Motor on the same Principle.

*LOUIS MILTON SCHMIDT (Dynamic Engineering), *New Britain.* On the Thomson-Houston System of Electric Lighting.

JAMES ALWARD SEYMOUR (Dynamic Engineering), *Auburn, N. Y.* On the Gaskill Pumping Engine at Saratoga Springs, N. Y.

WILLIAM VAN SCHOONHOVEN THORNE (Select), *New York City.* On Railroad Construction in the United States between 1880 and 1883.

GEORGE ELLIOT VERRILL (Civil Engineering), *New Haven.* On Deep Sea Sounding.

FREDERICK BREWSTER WHEELER (Dynamic Engineering), *Monroe.* On the Theory of the Dynamo.

HENRY HOWARD WHITEHOUSE (Biology), *Hartford.* On the Action of Pure Glucose and of Cinchonidine Sulphate on the Metabolism of the Body.

ARTHUR BRONSON ADAMS (Civil Engineering), *New Haven.* On Underground Electric Wires and their Enemies.

GRENVILLE FRENCH ALLEN (Civil Engineering), *New Haven.* Bridge Design with Working Drawings and Calculations.

PHILIP VANWYCK ANDERSON (Civil Engineering), *Sing Sing, N. Y.* On the Bismarck Bridge.

JAMES ARTHUR ATWOOD (Dynamic Engineering), *Wauregan.* On Turbine Wheels.

JOHN FRANK BABCOCK (Select), *Elmira, N. Y.* On the Execution of Charles I.

CLARENCE BLAKESLEE (Civil Engineering), *New Haven.* On Street Paving.

CLARENCE RUSSELL BRITTON (Select), *Dobbs Ferry, N. Y.* On the Division of Labor as exemplified in the Wire Industries of New Haven.

FRED SPENCER BULLENE (Chemistry), *Kansas City, Mo.* On the Quantitative Separation of Copper and Zinc.

ARTHUR CHANDLER COATES (Select), *Kansas City, Mo.* On the Weather Signal Service of the United States.

WILLIAM LEDLIE CULBERT (Biology), *Brooklyn, N. Y.* On the Influence of Potassium and Ammonium Bromides on the Metabolism of the Body.

JOHN JOSEPH FLATHER (Dynamic Engineering), *Bridgeport.* On the Manufacture of Sewing Machines.

WILLIAM HOLT GALE (Select), *New York City.* On Infectious Pneumo-Enteritis of the Pig.

JACOB PHILIP GOODHART (Select), *New Haven.* On the Civil Code of the Ancient Jews.

CHARLES LORD GRIFFITH (Agriculture), *San Francisco, Cal.* On Whale Fishery and the Refining of Whale Oil.

JOHN ETHAN HILL (Civil Engineering), *Mystic Bridge.* On the Sanitary Sewerage System of New Haven.

DAVID LEAVITT HOUGH (Dynamic Engineering), *Fort Wayne, Ind.* On Torpedoes, their History and Construction.

EDWIN YOUNG JUDD (Dynamic Engineering), *Hartford.* On an Invention for the Repeating Mechanism for Clocks.

AMOS WILLIAM KIMBALL (Civil Engineering), *Portland, Or.* On the Use of Steel and Iron as Armor.

ERA LAMB (Civil Engineering), *Franklin.* On the Location of the Railroads in New Haven.

PERCY LYFORD LANG (Select), *Waverly, N. Y.* On Egypt and the Soudan.

WILLIAM HEATH LYON, JR. (Select), *Brooklyn, N. Y.* On the Cotton Production of the United States.

CHARLES POND MCAVOY (Select), *Chicago, Ill.* On Beer Brewing and the Pneumatic System of Malting.

WILLIAM ADAIR MCDOWELL (Civil Engineering), *Lexington, Ky.* On Electric Lighting.

DANIEL WILLIAM MAHER (Civil Engineering), *New Haven.* On Sewers and Sewerage.

DANIEL DELEVAN MANGAM, JR. (Select), *Sing Sing, N. Y.* On the United States Life Saving Service.

WILLIAM EDWARD MARTIN (Biology), *Allentown, Pa.* On the Influence of Temperature on the Amylolytic Action of Saliva and Diastase of Malt.

EDWARD ALEXANDER MEREDITH (Civil Engineering), *Xenia, O.* On the Panama Ship Railway.

DEANE MILLER (Select), *New Rochelle, N. Y.* On Early Ships and Sailors.

HERBERT LINCOLN MITCHELL (Select), *New Haven.* On the Origin, Outbreak and Decline of Chartism.

JAMES MINOR MCGHEE (Chemistry), *Evansville, Ind.* On the General Anatomy of the Eye and its Muscles and Nerves.

WILLIAM ALPHEUS NETTLETON (Civil Engineering), *Kansas City, Mo.* On Railway Track Laying and Repairs.

TRUMAN HANDY NEWBERRY (Select), *Detroit, Mich.* On the Origin and Growth of the Bank of England.

ISAAC NORRIS, 3D (Dynamic Engineering), *Philadelphia, Pa.* An Analysis of the Mechanical Principles involved in a certain Apparatus for conveying Coal.

GEORGE WASHINGTON NORTON, JR. (Dynamic Engineering), *Louisville, Ky.* On the Theory and Use of the Steam Injector.

HENRY OLIVER (Chemistry), *Pittsburgh, Pa.* On Sulphur in Pig-Iron.

JOHN CUNNINGHAM OLIVER (Dynamic Engineering), *Pittsburgh, Pa.* On the Blast Furnace.

ABBOTT CHANDLER PAGE (Chemistry), *Fair Haven.* On the Volatility of Mercuric Chloride from Solutions.

WILLIS LAFAYETTE PERKINS (Select), *Portland, Me.* On the Selection of Food.

ROYAL WATSON PINNEY (Biology), *Derby.* On the Influence of Free and Combined Acids on the Proteolytic Action of Pepsine.

WILLARD CRAWFORD REID (Select), *Lakeville.* On Amateur Photography.

JOHN RICE (Dynamic Engineering), *Pottstown, Pa.* On the Construction of American Cable Roads.

WILLIAM TODD ROSS (Civil Engineering), *Belfast, Me.* On the Nicaragua Canal.

CHARLES GIDEON RUPERT (Civil Engineering), *New Haven.* On Geodetic Surveying.

FRANK ELBERT SANDS (Civil Engineering), *New Haven.* On Sewer Systems.

MURRAY SHIPLEY, JR. (Select), *Cincinnati, O.* On Early Dutch Trade in the East and West.

JOSEPH GODFREY SNYDACKER (Select), *Chicago, Ill.* On the Diseases of Cattle.

FRANK JEROME STEVENS (Dynamic Engineering), *New Haven.* On the Lever Escapement.

CURTIS TURNER (Dynamic Engineering), *Omaha, Neb.* (On Wheel Tests and Weir Measurements.

EDWARD SIMPSON WILSON (Biology), *New York City.* On the Germ Theory of Disease.

ENJAMIN ELIZUR WRIGHT (Civil Engineering), *Cromwell.* On the Plattsmouth Bridge.

PRIZES.

CLASS OF 1885.

r excellence in Civil Engineering, the prize divided between JOHN VENABLE HANNA, *Kansas City, Mo.*, and GEORGE ELLIOT VERRILL, *New Haven.*

r excellence in Dynamic Engineering, the prize divided between SIDNEY ARMOUR REEVE, *Dayton, O.*, and FREDERIC BREWSTER WHEELER, *Monroe.*

r excellence in German, the prize awarded to LOUIS MILTON SCHMIDT, *New Britain.*

CLASS OF 1886.

r excellence in the Mathematics of Junior Year, the prize divided between WILLIAM DAVID JOHNSON, *New Haven*, and HENRY HAYES WADSWORTH, *Glencoe, Minn.*

ecial prize for the largest collection of Plants. MARVIN D. HUBBELL, *New York City.*

CLASS OF 1887.

r excellence in all the Studies of the Freshman Year, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*, with honorable mention of EDGAR BURTON HARGER, *Oxford*, GEORGE BRINCKERHOFF RICHARDS, *New Haven*, ALFRED JOHN WAKEMAN, *Green's Farms*, EDWARD GILBERT WILLIAMS, *Essex*, and GEORGE HENRY WOOD. *Dayton, O.*

r excellence in Chemistry, the prize divided between ROBERT FISHER GIBSON *York, Pa.*, and EDGAR BURTON HARGER, *Oxford*, with honorable mention of ERWIN STARR SPERRY, *Ansonia*, and GEORGE HENRY WOOD, *Dayton, O.*

r excellence in Physics, the prize awarded to ROBERT CLAYTON AUGUR, *West Haven*, with honorable mention of ROBERT FISHER GIBSON, *York, Pa.*, and EDGAR BURTON HARGER, *Oxford.*

r excellence in Mathematics, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*, with honorable mention of ROBERT CLAYTON AUGUR, *West Haven*, and CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*

r excellence in Mechanical Drawing, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*

r excellence in German, the prize divided betwen ISADORE DYER, JR., *Galveston, Texas*, ROBERT FISHER GIBSON, *York, Pa.*, CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*, GEORGE BRINCKERHOFF RICHARDS, *New Haven*, and FRANK OTTO WALTHER, *Brooklyn, N. Y.*

r excellence in English Composition, 1st prize, HARRY LEON HAMLIN, *Chicago, Ill.*; 2d prizes, FRANKLIN TREAT PARLIN, *Casselton, Dakota*; GEORGE BRINCKERHOFF RICHARDS, *New Haven*; 3d prizes, HERBERT SPENCER BULLARD, *Hartford*; ARTHUR MANSFIELD EVERIT, *New Haven*; ROBERT FISHER GIBSON, *York, Pa.*; CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*; OSCAR HARMON SHORT, *New York City*; FRINK MANSFIELD SMITH, *East Haven*; and EDWARD GILBERT WILLIAMS, *Essex.*

PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1885-86.

CALENDAR.

1885.		
24 Sept.	Thursday,	First Term begins,
23 Dec.	Wednesday,	First Term ends.
1886.		**Winter Vacation of two weeks.**
7 Jan.	Thursday,	Second Term begins.
21 April,	Wednesday,	Spring Recess begins.
28 April,	Wednesday,	Spring Recess ends.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday,	Anniversary.
30 June,	Wednesday,	Commencement.
1, 2, 3 July,	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of twelve weeks.
21, 22 Sept.	Tues., Wedn.,	Examination for Admission.
23 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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REV. NOAH PORTER, D.D., LL.D.

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Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

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CHARLES S. HASTINGS,
Physics. (30 N. S. H.) 191 Bradley st.

HENRY W. FARNAM,
Political Economy and History. 43 Hillhouse av.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (5 S. H.) 32 Trumbull st.

* During the absence of Professor Brush in Europe for the current college year, the duties of Director will be discharged by Professor Wm. H. Brewer.

LECTURERS, INSTRUCTORS AND ASSISTANTS.

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER, *German.*		Tremont House.
MARK BAILEY, *Elocution.*	(150 F.)	200 Temple st.
JOHN H. NIEMEYER, Professor in Yale School of Fine Arts, *Free Hand Drawing.*		8 Art School.
FREDERICK R. HONEY, *Descriptive Geometry and Projection Drawing.*	(53 N. S. H.)	14 Lincoln st.
THOMAS W. MATHER, *Kinematics and Machine Design.*	(45 N. S. H.)	19 Warren pl.
SAMUEL L. PENFIELD, *Mineralogy.*	(2 P. M.)	14 S. H.
HORACE L. WELLS, *Analytical Chemistry.*		14 S. H.
SAMUEL E. BARNEY, *Mathematics and Civil Engineering.*		363 Elm st.
ALTON W. LEIGHTON, *Drawing.*		129 College st.
THOMAS B. OSBORNE, *Analytical Chemistry.*		260 Crown st.
LOUIS V. PIRSSON, *Analytical Chemistry.*		8 Prospect pl
WILLIAM PRICE, *French.*		139 Elm st.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

GRADUATE STUDENTS.

es Backus Ball, PH.B.,	*Washington, D. C.*,	A.
el Eben Barney, C.E.,	*New Haven*,	363 Elm st.
Bartholomew, PH.B.,	*Hudson, N. Y.*,	A.
h Augustus Blake, B.A.,	*New Haven*,	134 College st.
ım Booth, PH.B.,	*Cheshire*,	Cheshire.
t Park Campbell, PH.B.,	*New Haven*,	28 York sq.
ert DeWitt Carrington, PH.B.,	*New Haven*,	1169 Chapel st.
ge Wyckoff Cummins, PH.B.,	*Vienna, N. J.*,	297 York st.
d Guyct Dana, B.A.,	*New Haven*,	24 Hillhouse av.
y Holbrook Gladding, PH.B.,	*New Haven*,	270 Martin st.
e Judson Kelsey, PH.B.,	*Killingworth*,	Killingworth.
Kwai, B.A.,	*Kwongtung, China*,	318 George st.
ım Ellison Lockwood, PH.B., M.D.,	*Stamford*,	146 Dixwell av.
ım Wallace Nichols, PH.B.,	*Manitou Springs, Col.*	A.
Valentine Pirsson, PH.B.,	*New York City*,	8 Prospect pl.
es Gideon Rupert, PH.B.,	*New Market, Va.*,	109 High st.
s Alward Seymour, PH.B.,	*Auburn, N. Y.*,	114 High st.
ım Tuttle Shepard, PH.B.,	*Bristol*,	17 College st.
Prentice Terry, PH.B.,	*Brooklyn, N. Y.*,	90 High st.
ge Elliot Verrill, PH.B.,	*New Haven*,	86 Whalley av.
rick Brewster Wheeler, PH.B.,	*Monroe*,	409 Temple st.
r Howard Whitehouse, PH.B.,	*Hartford*,	N. S. H.
el Hubbard Williams, B.A., Amherst College.	*Glastonbury*,	128 High st.
lin Eldred Worcester, B.A., PH.B.,	*New York City*.	A.

GRADUATE STUDENTS, 24.

SENIOR CLASS.

William Allender,	*New London*,	68 w.
Gilbert Lincoln Husted Arnold,	*Stamford*,	107 Olive st.
William Wallace Atterbury,	*Detroit, Mich.*,	389 Temple st.
Silas Warren Bartlett,	*South Orange, N. J.*	46 Elm st.
Henry William Blake,	*New Haven*,	119 w.
John Marvin Blakeley,	*St. Paul, Minn.*,	46 Elm st.
Howard Cone Bolton,	*Cleveland, O.*,	65 w.
Percival Ranney Bolton,	*Cleveland, O.*,	65 w.
Louis Whitford Bond,	*New York City*,	61 w.
Thomas Stoddard Bronson,	*New Haven*,	1460 Chapel st.
Harry Lockwood Burns,	*Milford*,	63 Prospect st.
Silas Enoch Burrows,	*Mystic*,	1010 Chapel st.
Lewis Emerson Cadwell,	*New Haven*,	106 Liberty st.
Theodore Newton Case,	*Hartford*,	287 York st.
John Chamberlain,	*Kansas City, Mo.*,	389 Temple st.
Frederick William Darlington,	*West Chester, Pa.*,	289 York st.
Alexander Harrison Davis,	*Watertown*,	116 w.
John Edwin Doane,	*Chicago, Ill.*,	36 Elm st.
Joseph Osterman Dyer,	*Galveston, Tex.*,	55 Insurance Building.
Harvey Farrington,	*Croton, N. Y.*,	64 High st.
Joseph Essex Fitzsimons,	*Waterbury*,	107 Olive st.
Robert Elder Forster,	*Harrisburg, Pa.*,	44 Elm st.
William Washington Gordon, 3d,	*Savannah, Ga.*,	43 College st.
James Eugene Greenebaum,	*Chicago, Ill.*,	63 w.
Everett Mason Grimes,	*Oakland, Cal.*,	64 High st.
Harry Cloyd Hamill,	*Georgetown, Col.*,	287 York st.
David Neil Harper,	*Shippensburgh, Pa.*,	297 York st.
Frank Sperry Harrison,	*New Haven*,	562 Chapel st.
Willis Benjamin Herr,	*Denver, Col.*,	287 York st.
Jay Russell Hickox,	*South Britain*,	270 Martin st.
William Brisbane Hickox,	*Litchfield*,	64 w.
William Barlow Hill,	*Greenfield Hill*,	17 College st.
Abraham Lincoln Howes,	*Black Rock*,	389 Temple st.
William Evelyn Hutchings,	*Louisville, Ky.*,	43 College st.
Morison Thomas Hutchinson,	*Brooklyn, N. Y.*,	36 Elm st.
Abraham Lincoln Hyde,	*New Haven*,	179 Washington st.
William David Johnson,	*New Haven*,	92 Rosette st.
Thomas Coggeshall Knowles,	*San Francisco, Cal.*,	389 Temple st.
Harrie Sheldon Leonard,	*Washington, D. C.*,	90 Wall st.
Cornelius Fay Lynde,	*Rock Island, Ill.*,	1187 Chapel st.
Mahlon Henry Marlin,	*New Haven*,	236 George st.
Frederick Anderson Marsh,	*Kansas City, Mo.*,	1187 Chapel st.
Conrad Henry Matthiessen,	*Cornwall, N. Y.*,	36 Elm st.
Edwin Frank Meyer,	*Chicago, Ill.*,	66 w.

ge Perkins Miller,	*Utica, N. Y.,*	85 w.
y White Patten,	*North Haven,*	36 Elm st.
ge Eustis Potts,	*Philadelphia, Pa.,*	71 w.
im Acker Rice,	*St. Paul, Minn.,*	36 Elm st.
ir Jones Richmond,	*Providence, R. I.,*	43 College st.
el Bostwick Robbins,	*Lakeville,*	119 w.
ald Ronalds,	*New York City,*	43 College st.
nder Holley Rudd,	*Lakeville,*	389 Temple st.
r Rustin,	*Omaha, Nebr.,*	64 High st.
uel Frank Selz,	*Chicago, Ill.,*	66 w.
n Coupland Shaw,	*Buffalo, N. Y.,*	389 Temple st.
im Sanders Tevis,	*San Francisco, Cal.,*	36 Elm st.
Metcalfe Thomas,	*New York City,*	43 College st.
rt Townley,	*Cincinnati, O.,*	101 w.
e Pollok Devereux Townsend,	*Middletown,*	101 w.
as Brodhead VanBuren, Jr.,	*Englewood, N. J.,*	43 College st.
r Hayes Wadsworth,	*Glencoe, Minn.,*	Allingtown.
es Willcox,	*Omaha, Nebr.,*	43 College st.
vell Amasa Williams,	*Canterbury,*	61 Prospect st.
Stoughton Williams,	*Minneapolis, Minn.,*	46 Elm st.

SENIORS, 64.

JUNIOR CLASS.

Henry Frederick Adams,	*Westport*,	113 York st.
Robert Clayton Augur,	*West Haven*,	West Haven.
Elmer Ellsworth Bennett,	*Plainfield*,	126 High st.
Walter Pierpont Bigelow,	*New Haven*,	278 Orange st.
Herbert Spencer Bullard,	*Hartford*,	1136 Chapel st.
Lewis Alexander Burgess,	*Newark, N. J.*,	55 w.
Richard Augustus Chapman,	*Rye, N. Y.*,	64 w.
William Henry Coburn,	*Indianapolis, Ind.*,	133 College st.
Harry Fitch Coleman,	*Logansport, Ind.*,	223 York st.
Lewis Atterbury Conner,	*New Albany, Ind.*,	389 Temple st.
David Mark Cummings,	*Chicago, Ill.*,	36 Elm st.
Julius Gilbert Day,	*Seymour*,	205 Orange st.
William Greenhow Doane,	*Omaha, Nebr.*,	64 High st.
Edward Warburton Durant, Jr.,	*Stillwater, Minn.*,	43 College st.
Isadore Dyer, Jr.,	*Galveston, Tex.*,	31 Trumbull st.
Arthur Mansfield Everit,	*New Haven*,	109 Elm st.
Raymond Thomson French,	*Seymour*,	36 Elm st.
Francis Frederic Georger,	*New York City*,	36 Elm st.
Robert Fisher Gibson,	*York, Pa.*,	297 York st.
Charles Joseph Goldmark.	*New York City*,	57 w.
Wilfred Elizur Griggs,	*Waterbury*,	55 Insurance Building.
George Conradt Ham,	*Washington Hollow, N. Y.*,	44 Elm st.
Harry Leon Hamlin,	*Chicago, Ill.*,	43 College st.
Edgar Burton Harger,	*Oxford*,	150 College st.
Herbert Leopold Hart,	*Chicago, Ill.*,	63 w.
James Henry Hayden,	*New York City*,	58 w.
Joseph Cooke Jackson, Jr.,	*New York City*,	60 w.
Lawrence Bates Jenckes,	*Stamford*,	64 w.
Leonard Abbot Jenkins,	*Dresden, Saxony*.	124 w.
Charles Sherman Jewett,	*Buffalo, N. Y.*,	143 College st.
John Edwin Judson,	*New Haven*,	142 St. John st.
Frederick Sheffield Kellogg,	*Utica, N. Y.*,	43 College st.
Grayson Guthrie Knapp,	*Auburn, N. Y.*,	86 w.
Charles Wilbur Knox,	*Pittsburgh, Pa.*,	36 Elm st.
John Stewart Kulp,	*Wilkesbarre, Pa.*,	1161 Chapel st.
Isaac Eugene Leonard,	*Chicago, Ill.*,	203 York st.
Edward Linsley Maltby,	*Northford*,	297 York st.
Harry Zeller Marshall,	*Dayton, O.*,	90 Wall st.
Harley James Morrison,	*Cincinnati, O.*,	60 w.
William Partridge Ordway,	*Boston, Mass.*,	36 Elm st.
Edward Horatio Parker,	*Detroit, Mich.*,	43 College st.
Edmund Bishop Patterson,	*Allegheny City, Pa.*,	8 Prospect pl.
Frank Adelbert Paul,	*New Haven*,	27 Washington st.
Charles Eugene Phillips,	Southington,	14 Prospect pl.

am Thomas Rainey,	*Cleveland, O.*	68 w.
k Clark Reed,	*Pittsburgh, Pa.,*	203 York st.
is Smith Reynolds,	*Poughkeepsie, N. Y.,*	43 College st.
ge Brinckerhoff Richards,	*New Haven,*	43 Elm st.
Robert Wheaton Sargent,	*Chicago, Ill.,*	36 Elm st.
am Marcelin Scaife,	*Allegheny City, Pa.,*	203 York st.
r Harmon Short,	*New York City,*	43 College st.
ırd Arthur Smith,	*Middletown,*	8 Prospect pl.
: Mansfield Smith,	*East Haven,*	East Haven.
ge H. Smith,	*Canajoharie, N. Y.,*	43 College st.
n Starr Sperry,	*Ansonia,*	41 High st.
ɔn Pierpont Stevens,	*New Haven,*	561 Howard av.
ur Peale Summers,	*Colorado Springs, Col.,*	126 High st.
am Conquest Tucker,	*New York City,*	86 w.
ard Beecher Tuttle,	*Naugatuck,*	242 York st.
d John Wakeman,	*Green's Farms,*	113 York st.
k Otto Walther,	*Brooklyn, N. Y.,*	203 York st.
aniel P. Washburn,	*Bridgewater, Mass.,*	223 York st.
< Warren Wentworth,	*Chicago, Ill.,*	1161 Chapel st.
ırd Gilbert Williams,	*Essex,*	47 Stanley st.
ge Henry Wood,	*Dayton, O.,*	124 w.
rt McKnight Woods,	*New Haven,*	364 George st.

JUNIORS, 66.

FRESHMAN CLASS.

Arthur Chambers Alexander,	*Honolulu, H. I.*	59 Prospect st
John Childe Anderson,	*Sing Sing, N. Y.*,	59 w.
Joseph Albright Archbald,	*Scranton, Pa.*,	223 York st.
Gardner Ball, Jr.,	*San Francisco, Cal.*,	109 Wall st.
William Hill Bean,	*New Haven*,	40 Pleasant st.
Charles Bart Berger,	*Denver, Col.*,	201 Orange st.
George Bart Berger,	*Denver, Col.*,	201 Orange st.
Theodore Whitney Blake,	*New Haven*,	134 College st.
Marshall Latham Bond,	*New York City*,	61 w.
William Tillinghast Bull,	*Newport, R. I.*,	143 York st.
George Robert Carter,	*Honolulu, H. I.*,	107 Wall st.
William Clarke Catlin,	*Providence, R. I.*,	29 Lynwood st.
James Henry Coleman,	*New York City*,	9 Elm st.
George David Colton,	*Collinsville*,	1169 Chapel st.
John Nesbitt Conyngham,	*Wilkesbarre, Pa.*,	120 High st.
Charles Edward Curtis,	*New Haven*,	138 Dwight st.
Richard Sydney Curtiss,	*Stratford*,	59 Prospect st.
Jesse Chase Dann,	*Buffalo, N. Y.*,	421 Temple st.
Henry Lewis Davis,	*Wallingford*,	103 Wall st.
George Howard Davison,	*New York City*,	14 Lincoln st.
William Henry Davol, Jr.,	*Brooklyn, N. Y.*,	103 Wall st.
Carlton Melville DeWolf,	*New York City*,	84 Wall st.
Robert Russel Dickey,	*Dayton, O.*,	237 Orange st.
John Eufemio Dockendorff,	*Brooklyn, N. Y.*,	552 Chapel st.
John Ambrose Doolittle,	*New Haven*,	216 Orange st.
John Feeter Easterbrook,	*New Haven*,	82 York sq.
Frank Harold Farquhar,	*York, Pa.*,	114 High st.
John Ellis Field,	*Denver, Col.*,	393 Temple st.
Richard Huntington Franchot,	*Schenectady, N. Y.*,	62 w
Pedro Florentino Francke,	*New York City*,	74 High st.
Deane Funk,	*McLean, Ill.*,	395 Temple st.
Henry Kellogg Goetchius,	*New York City*,	86 Wall st.
James Douglas Gold,	*West Cornwall*,	65 Grove st.
Addison Graves,	*New London*,	56 w.
Franklin Moses Gray,	*Chicago, Ill.*,	393 Temple st.
Howard Greer, Jr.,	*Chicago, Ill.*,	6 Prospect pl.
Matthew Griswold, Jr.,	*Erie, Pa.*,	150 College st.
Stephen Benedict Grummond, Jr.,	*Detroit, Mich.*,	395 Temple st.
Fred. R. Hamlin,	*Chicago, Ill.*,	1179 Chapel st.
Charles Merritt Heminway,	*Watertown*,	237 Orange st.
Edwin Richard Hodge,	*Washington, D. C.*,	8 Prospect pl.
Noble Foster Hoggson,	*New Haven*,	126 York st.
George Snowden Howland,	*Newport, R. I.*,	117 Elm st.
Howard Livingstone Isbell,	Union City,	28 Ridge st., Cedar Hill.

Harry Garrybrant Jenner,	*Dayton, O.,*	125 Dwight st.
Harry Lydstone Johnson,	*New Haven,*	25 Eld st.
Cyrus Field Judson,	*New York City,*	61 Grove st.
George Converse Kimball,	*Hartford,*	219 York st.
Felix Kleeberg,	*New Haven,*	14 Orange st.
Edward Lambert Leeds,	*Stamford,*	295 York st.
Thomas Albert Legler,	*Dayton, O.,*	237 Orange st.
Louis LeSassier,	*New Orleans, La.,*	393 Temple st.
Edwin Hoyt Lockwood,	*New Canaan,*	59 Prospect st.
Samuel Harkness McCrea, Jr.,	*Chicago, Ill.,*	55 Trumbull st.
George Grant Mason,	*Milburn, Ill.,*	136 College st.
William Smith Mason,	*Milburn, Ill.,*	136 College st.
Charles Griffin Miller,	*New Rochelle, N. Y.,*	421 Temple st.
Charles Edward Montgomery,	*San Francisco, Cal.,*	76 Howe st.
Edward Steward Moore,	*New London,*	56 w.
Augustus Lester Moss,	*Sandusky, O.,*	62 w.
James Augustus Nelson,	*Bridgeport,*	146 York st.
Edward Marshall Ney,	*Hartford,*	154 Grove st.
Charles Norris, Jr.,	*New York City,*	150 College st.
Elbert Ellsworth Norton,	*New Haven,*	33 Pearl st.
Selden Yale Osborn,	*New Haven,*	232 York st.
Frank Wyman Parmerter,	*Plattsburgh, N. Y.,*	39 Lynwood st.
John Erskine Patrick,	*Omaha, Nebr.,*	64 High st.
Daniel Tucker Coffin Perkins,	*San Francisco, Cal.,*	82 Wall st.
Francis Cole Pratt,	*Hartford,*	223 York st.
John Goodell Prouty,	*Spencer, Mass.,*	237 Orange st.
Edwin Wright Robinson,	*New Haven,*	255 Ferry st.
Solomon Franklin Rupert,	*New Market, Va.,*	109 High st.
Henry Pinney Sage,	*New Haven.*	42 College st.
Henry Charles Schwab,	*Chicago, Ill.,*	160 Wooster st.
Charles Kirtland Shelton,	*Bridgeport,*	103 Wall st.
Shiukichi Shigemi,	*Imabari, Japan,*	330 Orange st.
Orville Emerson Sloat,	*New Haven,*	183 Wooster st.
Ernest Ellsworth Smith,	*New Haven,*	16 Hughes pl.
Percey Franklyn Smith,	*New Haven,*	4 Home pl.
Ralph Hebert Smith,	*Waterbury,*	295 York st.
Frederick William Spanutius,	*New Haven,*	180 Chestnut st.
Stanley Matthews Stagg,	*Frankfort, Ky.,*	201 Orange st.
Charles Weaver Stewart.	*Newport, R. I.,*	143 York st.
Howard Canning Taylor,	*Green's Farms,*	113 York st.
George Parker Thompson,	*New York City,*	152 Grove st.
Charles Alling Tuttle,	*New Haven,*	364 Orchard st.
Morgan Walcott,	*New York City,*	389 Temple st.
Frank Nehemiah Waterman,	*New Britain,*	35 High st.
Charles Spencer Wells,	*Southport,*	86 Whitney av.
Ralph McIntosh Wilcox,	*Portland,*	254 York st.
Hubert Kip Wood,	*Cleveland, O.,*	136 College st.
Frank Clark Woodruff,	*Orange,*	41 High st.
Albert *Joseph Young,*	*Evanston,* Ill.,	55 Trumbull st.

FRESHMEN, 93.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Joseph Stanley Brown,	*Washington, D. C.*,	S. H.
Charlotte Eliza Bush,	*New Haven*,	45 Whalley av.
Katharine Jeannette Bush,	*New Haven*,	45 Whalley av
Abner Reeder Chambers, Jr.,	*Trenton, N. J.*,	59 Grove st.
Frank Cramer,	*Appleton, Wisc.*,	112 Davenport av.
Ludwig Otterson Kellogg,	*San Francisco, Cal.*,	36 Elm st.
Francis Timothy Smith,	*Simsbury*,	7 Pearl st.
Warren A. Spalding,	*New Haven*,	89 Church st.
Francis Lewis Sperry,	*Tallmadge, Ohio*,	9 Library st.

SPECIAL STUDENTS, 9.

SUMMARY.

Graduates,	24
Seniors,	64
Juniors,	66
Freshmen,	93
Special,	9
	256

SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department

of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum and Free Hand Drawing in the Art School. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures instruments for field practice.

8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board of 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY or, in two additional years of Engineering study, that of CIVIL ENGINEER or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the

Department of Philosophy and the Arts for not less than two years in assiduous and careful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor RICHARDS, in dynamic engineering.

Professor HASTINGS, in selected subjects in physics, and guidance in laboratory work.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Enigneering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid or a similar amount of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula, for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—Including the Analytical Theory of the Trigometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's, or Richards's, or Wentworth's Plane Trigonometry, or in the Plane Trigonometry of Oliver, Wait and Jones. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

nometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1886, take place at North Sheffield Hall, on Thursday, Friday, and Saturday, July 1, 2, 3 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 21, 22 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1886 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, July 1, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Enginering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical lessons, in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working-drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following Courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. Cooke's *Chemical Philosophy*. Roscoe and Schorlemmer's *Treatise* is required for reference. *Qualitative Analysis*—Fresenius's. *Laboratory Practice*. *Blowpipe Analysis*. *German*. *French*.

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French*. *German*.

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French*.

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's. *Mineralogy* (optional). *French*.

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German*. *French*.

SECOND TERM—*Mathematics*—Intergral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German*. *French*.

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Preliminary and final Location of line of Railroad, (Laying out of work), with calculations of Excavation and Embankment and Sections. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Designing of Engineering Structures. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions: Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Principles of Mechanism*—Kinematics. *Shop Visiting*—Sketching Machine Details and Tools. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Principles of Mechanism*—Applied Kinematics; Transmission of Power by Belts and Gearing; Forms of Teeth of Wheels; Cams; Parallel Motions, etc. *Shop Visiting*—continued. Sketching Machinery and Study of Mechanical Processes. *Study of Steam Engine*—begun. *Drawing*—Descriptive Geometry, concluded; Perspective and Shadows; Machine Details.

SENIOR YEAR:

FIRST TERM—*Applied Mechanics*—Friction; Moment of Inertia; Centrifugal Force: Elasticity and Strength of Materials; Strains in Structures; Theory of Flexure and Torsion; Construction of Roofs and Bridges; Equilibruim and Pressure of Fluids; Theory of Flotation; Flow of Fluids in pipes and channels; Resistance of Ships. *Machine Designing*—Practical Exercises in Designing Machine Details and Simple Machines. *Study of the Steam Engine*—continued. *Shop Visiting*—Inspection of Machines and Study of Processes; Reports of Visits.

SECOND TERM—*Hydrodynamics*—Theory of Water-Wheels, Turbines, and Water Pressure Engines. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—continued. Practical Exercises in designing Machinery for Shaping Metals, Hoisting, Pumping, etc. Designs and Working Drawings of Steam Engines and Boilers; Estimates of Weight and Cost of Machinery. *Shop Visits and Reports.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry* — Lectures and Recitations. *Geology* — Dana's. *Botany. Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoology. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, or Zoology, Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR.

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology* — Laboratory Practice; Recitations; Lectures. *Botany* — Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structures and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. Cooke's *Chemical Philosophy*. Roscoe and Schorlemmer's Treatise is required for reference. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical exercises in Phenogamous Plants; Excursions. *German*. *French*.

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice, and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical exercises, Lectures, and Excursions. *Geology*—Dana's. *French*.

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology*. *Geology*—Dana's. *Zoölogy*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French*.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Green's Short History of the English People. *French*. *German*.

SECOND TERM—*Mineralogy*—Lectures. *Astronomy*. *Botany*—Lectures; Excursions; Laboratory Practice. English—Chaucer, Bacon, Shakspere. *History*—Green's History, continued. German. French.

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions *Zoölogy*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction in this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best

methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoölogy excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collection at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and

by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed working drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practise, and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on page 37.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 35.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 23, 1886. The first term begins twelve weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (*See Calendar, p. 20.*)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 29, 1886, and at or about the same time in the year 1887, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

APPENDIX I.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1885, upon which applicants for admission were examined at the June and September examinations.

ARITHMETIC.

JUNE, 1885.

1. Find the greatest common divisor and the least common multiple of 9249 and 10920.

2. Divide $\frac{2}{5}$ of $7\frac{3}{4}$ by $\frac{4}{5}$ of $11\frac{4}{11}$.

3. Divide 10.85 by 0.0775.

4. A merchant sold a lot of flour at $8.40 per barrel and thereby gained 20 per cent. He afterward sold another lot of the same flour for $203 and thereby gained 16 per cent. How many barrels were there in the last lot?

5. A sends B $5000, with which B is to purchase lumber after providing for his commission at 2 per cent. How much will B have to expend for lumber and what will be the amount of his commission?

6. Extract the square root of 0.001 to the fourth decimal place.

7. Give the table of Troy weights and that of metric weights. How is the gram determined? About what is its value in grains?

ARITHMETIC.

SEPTEMBER, 1885.

1. Resolve 2346 into its prime factors.

2. Add $\frac{4}{7}$ of $18\frac{3}{11}$ and $\frac{11}{12}$ of $\frac{4}{5}$ of $6\frac{3}{11}$.

3. What decimal part of a degree is 52′ 43″.5?

4. If $9\frac{1}{4}$ yds. of cloth cost $23\frac{1}{8}$, how many yards can be bought for $38\frac{7}{16}$?

5. At what rate per cent. per annum, simple interest, will $350 amount to $423.50 in 5 yrs. 3 mos.?

6. The area of a square is 655.36 square feet; what is the length of its side?

6. A cubical vessel contains 1331 liters; what is the length of its edge in meters?

PLANE GEOMETRY.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Prove that if in any triangle one side be greater than another, the angle opposite that side will be greater than the angle opposite the other.

2. Determine how many sides the polygon has the sum of whose interior angles is equal to the sum of its exterior angles. Explain your method.

3. (*a*) How does the perpendicular from the center of a circle upon a chord divide the chord and the arc which it subtends? (*b*) How is an angle inscribed in a circle measured? (*c*) How is each angle between two intersecting chords of a circle measured? (*d*) What is the locus of the center of a circle whose circumference passes through two given points? Give proof of your answer.

4. Divide a given finite straight line into any given number of equal parts and prove your construction.

5. Given two arcs of circles of 30° whose radii are 1 ft. and 2 ft. respectively; compare their lengths and the areas of the corresponding sectors; and calculate the length of the first and the area of its corresponding sector.

6. If two sides of a triangle be given, what angle will these sides form when its area is a maximum? Give proof.

SOLID AND SPHERICAL GEOMETRY.

JUNE, 1885.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. If a line intersect a plane it makes a less angle with its projection on the plane than with any other line in the plane passing through the point of intersection.

2. The sum of any two face angles of a trihedral angle is greater than the third.

3. Define a regular polyhedron. How many regular polyhedrons are there? Give their names and define each of them.

4. All lines tangent to a sphere from the same external point are equal and touch the sphere in a circle of the sphere.

5. Define a conical surface and a cylindrical surface.

6. The volume of a cone is V; what is the volume of a similar cone whose surface is *n* times as great?

GEOMETRY.

SEPTEMBER, 1885.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Prove that two triangles are equal when the three sides of the one are equal respectively to the three sides of the other.

2. A straight line cannot intersect the circumference of a circle in more than two points.

3. Upon a given straight line to describe a segment which shall contain a given angle.

4. Define similar polygons and prove that the perimeters of two similar polygons are to each other as any two homologous sides.

5. The height of a room is ten feet; how can a point in the floor directly under a given point in the ceiling be determined with a twelve-foot pole?

6. If two straight lines be cut by three parallel planes, their corresponding segments are proportional.

7. Find the volume of a regular tetrahedron whose edge is E.

8. Find the area of a spherical triangle whose angles are 65°, 75°, 80°, the radius of the sphere of which it forms a part being 10 feet.

ALGEBRA TO QUADRATICS.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Resolve the following expressions into factors: a^3-8b^3; a^3+27b^3; a^4-81b^4; $4a^{4m}-4a^{2m}b^n+b^{2n}$.

2. Divide $\frac{x}{1+x}+\frac{1-x}{x}$ by $\frac{x}{1+x}-\frac{1-x}{x}$ and express the quotient in its simplest form.

3. Given $\frac{ax}{a-b}+4b=\frac{cx}{3a+b}$ to find the value of x.

4. Given $\frac{1}{x}+\frac{2}{y}=a$ and $\frac{3}{x}+\frac{4}{y}=b$ to find the values of x and y.

5. Simplify the following expressions:

$\sqrt{108}-\sqrt{72}$; $(2+3\sqrt{5})(3\sqrt{5}-2)$; $\sqrt[3]{a^6x^{12}}$; $\sqrt{a+b}\times\sqrt{a-b}$.

6. Reduce $\sqrt{\frac{a+b}{a-b}}$ to a fraction having a rational denominator.

ALGEBRA FROM QUADRATICS.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Given $\frac{x+2}{x-1} - \frac{4-x}{2x} = \frac{7}{3}$ to find the value of x.

2. Form a quadratic whose roots shall be 3 and $-\frac{2}{7}$.

3. Given $x^2+y^2=436$ and $x-y=14$ to find the values of x and y.

4. Given the first term a, the ratio r, and the number of terms n, of a geometric progression, to deduce a formula for the sum of the progression.

5. How many different products of 2 factors can be formed from n different numbers?

6. Expand $\frac{3+2x}{5+6x}$ into a series of ascending powers of x by the method of indeterminate coefficients.

ALGEBRA.

SEPTEMBER, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Simplify $\dfrac{\dfrac{a^2+b^2}{b} - a}{\dfrac{1}{b} - \dfrac{1}{a}} \times \dfrac{a^2-b^2}{a^2+b^2}$.

2. Given $\frac{x}{a} + \frac{y}{b} = c$ and $\frac{ax}{by} = -c$ to find the values of x and y.

3. Write four terms of the development of $\left(1 + \frac{a}{x^2}\right)^n$.

4. (1) Write equivalent expressions for a^0b^{-m}, $\sqrt[3]{a^2}$, $a^{\frac{3}{2}}$.

   (2) Simplify $\sqrt{12} \times \sqrt[3]{72}$; $\sqrt[4]{49}$; $\sqrt[3]{8x^6}$; $\sqrt[3]{54} + \sqrt[3]{128}$.

5. Given $3-\sqrt{x^2-1} = 2x$ to find the values of x.

6. Resolve $3x^2-6x+10$ into factors.

7. Given $x^2+xy=15$ and $xy-y^2=2$ to find the values of x and y.

8. If each of n straight lines intersects all the others, not more than two lines intersecting in the same point, how many points of intersection will there be?

9. Find the value of the repeating decimal $0.72525+$

10. Develop $\frac{1+x}{2+3x}$ into a series by the method of indeterminate coefficients (four terms of the series will suffice).

TRIGONOMETRY.

JUNE, 1885.

[State what text-book you have studied on the subject and to what extent.]

1. Describe the different ways of measuring angles in Trigonometry. How many degrees are there in the angle $\frac{\pi}{6}$?

2. Define the sine, tangent and secant of an angle and represent each by a straight line.

3. How many angles are there having the same given function, sine, tangent, etc.? Name five angles having the cosine $\frac{1}{2}$.

4. Show that $\sin(\pi+\varphi)=-\sin\varphi$; also that

$$\tan\left(\frac{\pi}{2}+\varphi\right)=-\cot\varphi.$$

5. Given $\tan\varphi=\frac{m}{n}$ to find $\sin\varphi$ and $\cos\varphi$.

2. Show that $\cos 2\varphi=\cos^2\varphi-\sin^2\varphi=1-2\sin^2\varphi$; also $\sin\frac{1}{2}\varphi=\sqrt{\frac{1}{2}(1-\cos\varphi)}$

7. In a triangle A B C given $A=120°\ 10'$, the side a (opposite A) $=4256.6$, the side b (opposite B) $=2267.8$ ft. to find the remaining parts of the triangle. Is there more than one solution possible with these data?

TRIGONOMETRY.

SEPTEMBER, 1885.

[Note.—State what text-book you have studied on the subject and to what extent.]

1. Give the algebraic signs of the different trigonometrical functions for an angle terminating in each of the four quadrants.

2. Express the sine, tangent and secant of $\frac{3}{2}\pi-\alpha$ in functions of α.

3. Find the value of $\tan\alpha$ in terms of $\sin\alpha$.

4. Show that $\tan\left(\frac{\pi}{4}-\alpha\right)=\frac{1-\tan\alpha}{1+\tan\alpha}$

5. a, b, c, being the sides of triangle ABC respectively opposite the angles A, B, and C, show that

$$\frac{\tan\frac{1}{2}(A-B)}{\tan\frac{1}{2}(A+B)} = \frac{a-b}{a+b}.$$

What is this formula used for?

6. In the triangle ABC, given the sides BC = 2575 ft., AC = 2560.7 ft., AB = 2601.6 ft.; to find the angle A.

ENGLISH GRAMMAR.

JUNE, 1885.

1. Name the relative pronouns. State the distinction in their use, and give the rule for the agreement of the relative with the antecedent.

2. State the difference between the strong (or old) and the weak (or new) conjugation of the English verb, and give three illustrative examples of each.

3. Parse the following sentence:

He lived long enough to see those who had been his enemies become his friends.

ENGLISH.

1. What are the two methods of comparison of the adjective? Compare the adjectives that are compared irregularly.

2. State the distinction between the strong, or old, and the weak, or new, conjugation of the English verb, and give three illustrative examples of each.

3. Parse the following sentence:

What was thought of his conduct was a subject about which he gave himself no concern.

CAESAR.

JUNE 25, 1885.

I. Translate as literally as possible:

1. Divitiăcus respondit: *Hoc* esse miseriorem gravioremque *fortunam* Sequanōrum quam reliquorum, quod *soli* ne in occulto quidem queri neque auxilium implorare auderent, absentisque

Ariovisti crudelitatem, velut si coram adesset, horrerent, propterea quod *reliquis* tamen fugae facultas daretur; *Sequănis* vero, qui intra fines suos Ariovistum recepissent, quorum oppida omnia in potestate ejus essent, omnes cruciatus essent perferendi.

2. At totis fere a fronte et ab sinistrā parte nudatis castris, quum in dextro cornu legio duodecima et non magno ab eā *intervallo* septima constitisset, omnes Nervii, confertissimo *agmine*, *duce* Boduognāto, qui summam imperii tenebat, ad eum locum contenderunt; quorum pars aperto *latere* legiones circumvenire, pars summum castrorum locum petere coepit.

3. Quo proelio bellum Venetōrum totiusque orae maritimae confectum est. Nam quum omnis juventus, omnes etiam gravioris *aetatis*, in quibus aliquid *consilii* aut dignitatis fuit, *eo* convenerant, tum *navium* quod ubique fuerat, unum in locum coëgerant; quibus amissis, reliqui neque quo se reciperent neque quemadmodum oppida defenderent, habebant.

4. Navibus circiter octoginta onerariis *coactis contractis*que, quot satis esse ad duas transportandas legiones existimabat, quod praeterea navium longarum habebat, quaestori, legatis, praefectisque *distribuit*. Huc accedebant octodecim onerariae naves, quae ex eo loco ab millibus passuum octo vento *tenebantur*, quo minus in eundem portum *pervenire possent*.

5. His aliquantum itineris *progressis*, quum jam extremi essent in prospectu, equites a Quinto Atrio ad Caesărem *venerunt*, qui nuntiarent, superiore nocte, maximā *coortā* tempestate, prope omnes naves afflictas atque in litore *ejectas* esse; quod neque ancorae funesque subsisterent, neque nautae gubernatoresque vim tempestatis *pati* possent.

6. At ii, qui in jugo constiterant, nullo etiam nunc usu rei militaris *percepto*, neque in eo, quod probaverant, consilio *permanere*, ut se loco superiore *defenderent*, neque eam quam *prodesse* aliis vim celeritatemque *viderant*, imitari potuerunt; sed se in castra recipere *conati* iniquum in locum demiserunt.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and rewrite it so as to make it direct.

LATIN. (EXERCISES AND GRAMMAR.)

JUNE 25, 1885.

I. *Translate into Latin:*

1. The enemy[1] (pl.) take-a-position[2] at-the-foot-of[3] the mountain.[4]

2. The enemy will take a position at the foot of the mountain.

3. Caesar was informed[5] that the enemy had taken a position at the foot of the mountain. (*Give two versions, one of them illustrating direct statement.*)

4. The lieutenant[6] sends[7] a messenger to inform Ceasar that the enemy have taken a position at the foot of the mountain.

5. When battle[8] had been joined[9] (*abl. abs.*) the Gauls endeavored[10] to break through[11] the line[12] of the Romans.

6. The Gauls form the plan of breaking through the line of the Romans.

7. The line of the Romans was broken through by the Gauls.

8. Cæsar hastens[13] into the territory[14] of the Nervii to anticipate[15] their plans[16].

9. Cæsar hastened into the land of the Nervii to anticipate their plans.

10. Cæsar lived many years in Gaul and died at Rome.

[1]hostis.	[5]certior fieri.	[9]committĕre.	[13]contendĕre.
[2]considĕre.	[6]legatus.	[10]conāri.	[14]ager. (Use pl.)
[3]sub.	[7]mittĕre.	[11]perrumpĕre.	[15]praevenīre.
[4]mons.	[8]proelium.	[12]acies.	[16]consilium.

II. *Latin Grammar:*

1. Decline *urbs, dies, facilis, major.*

2. Decline *tu, qui, alius.*

3. Compare *altus, felix, facilis, multus, fortiter, bene, maxime.*

4. Give the synopsis, both active and passive, of *vinco* (*vincere, vici, victum*), and *do* (*dăre, dedi, datum*).

5. Give the rules for the government of cases by prepositions.

CAESAR.

SEPTEMBER 22, 1885.

I. *Translate as literally as possible:*

Ad haec Ariovistus respondit: *Jus* esse belli, ut, qui vicissent, *iis*, quos vicissent, quemadmodum vellent, imperarent: item populum *Romānum* victis non ad alterius praescriptum, sed ad

suum arbitrium *imperare* consuesse. Si ipse *populo* Romāno non praescriberet, quemadmodum suo *jure* uteretur, non oportere sese a populo Romāno in suo jure impediri.

2. Quibus omnibus *rebus* permoti equites Trevĭri, quorum inter Gallos virtutis opinio est singularis, qui auxilii causā ab civitate ad Caesărem missi venerant, quum *multitudine* hostium castra nostra compleri, nostras legiones premi et paene circumventas teneri, calones, equites, funditores, Numĭdas, diversos dissipatosque in omnes partes *fugere* vidissent, desperatis nostris rebus, *domum* contenderunt.

3. Eodem fere tempore Publius Crassus, quum intelligeret in his locis *sibi bellum* gerendum, ubi paucis ante *annis* Lucius Valerius Praeconīnus *legatus* exercitu pulso interfectus esset, atque unde Lucius Mallius proconsul impedimentis amissis profugisset, non mediocrem *sibi* diligentiam adhibendam intelligebat.

4. Exiguā parte aestatis reliquā, Caesar, etsi in his locis, quod omnis Gallia ad septemtriones *vergit* maturae sunt hiemes, tamen in Britanniam *proficisci* contendit, quod omnibus fere Gallĭcis bellis hostibus nostris inde subministrata auxilia *intelligebat;* et si tempus anni ad bellum *gerendum deficeret*, tamen magno sibi usui fore *arbitrabatur*, si modo insulam adisset et genus hominum *perspexisset*, loca, portus, aditus *cognovisset.*

5. Caesar, *exposito* exercitu et loco castris idoneo capto, ubi ex captivis cognovit, quo in loco hostium copiae consedissent, cohortibus decem ad mare relictis et equĭtibus trecentis, qui praesidio navibus essent, de tertiā vigiliā ad hostes contendit, eo minus *veritus* navibus, quod in litore molli atque aperto deligatas ad ancoram *relinquebat.*

6. Segni Condrūsique, ex gente et numero Germanōrum, qui sunt inter Eburōnes Trevĭrosque, legatos ad Ceasărem miserunt, *oratum*, ne se in hostium numero duceret neve omnium Germanōrum, qui essent citra Rhenum, unam esse causam judicaret; nihil se de bello cogitavisse, nulla Ambiorĭgi auxilia *misisse.*

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and re-write it so as to make it direct.

HISTORY OF THE UNITED STATES.

JUNE, 1885.

1. Give the dates of the following events: Wolfe's capture of Quebec, settlement of Jamestown, Missouri Compromise, John Cabot's first voyage, and state who was president in 1805, 1815, 1825, and 1835.

2. Give an outline of the colonization of the Carolinas and of their early government.

3. Give an account of the Stamp Act Congress.

4. Describe the battles of the Brandywine and of Germantown.

5. When and under what circumstances was Florida obtained by the United States?

6. What was Clay's Omnibus Bill?

N. B.—The dates are to be given with every question.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1885.

1. Give the dates of the following events: Repeal of the Stamp Act, settlement of New Haven, Raleigh's first expedition, surrender of Mexico, and state who was president in 1803, 1813, 1823, 1833.

2. Give an account of the settlement of Massachusetts Bay.

3. Describe the battles of Trenton and Saratoga.

4. Give the principal events in the administration of Jackson.

5. State the circumstance of the annexation of Texas and its results.

6. What were the causes of the War of the Rebellion?

N. B.—The dates are to be given with every question.

GEOGRAPHY.

JUNE, 1885.

1. Bound the State of Georgia; give the names and situation of two cities in it.

2. Where does the Columbia River rise; what is its course, where does it empty, what States and Territories does it pass through or *touch*?

3. What countries touch the Indian Ocean or its bays and gulfs?

4. Bound France; give the names and positions of three of its cities and two of its rivers.

5. Where is Afghanistan? bound it; name any city or place in it.

6. Where are the following cities: Bremen, Bombay, Tokio, Memphis, Valparaiso and Singapore?

GEOGRAPHY.

SEPTEMBER, 1885.

1. Bound the State of California; give the name and position of two cities in it.

2. Where does the Potomac River rise, what is its course, where does it empty, what States or Territories does it pass through or touch?

3. Name in their order, beginning south, the countries of South America, which touch the Atlantic Ocean or Caribbean Sea.

4. What islands constitute the Empire of Japan? describe their position; give the name and situation of one city in Japan.

5. Describe the Alps; what countries are by or near them; what rivers rise in them and where do these rivers run?

6. Where are the following cities: Alexandria, Liverpool, Portland, Hamburg, Herat, Valparaiso?

APPENDIX II.

CATALOGUE OF GRADUATES: 1852–1884.

CATALOGUE OF GRADUATES 1852–1884.

The following list includes the names of all those students in the Sheffield Scientific School who have been admitted by the President and Fellows of Yale College to the degree of Bachelor of Philosophy (Ph.B.), Doctor of Philosophy (Ph.D.), Civil Engineer (C.E.), or Dynamic Engineer (D.E.), from 1852, when degrees were first conferred on its students, to 1884 inclusive. The larger number have been undergraduate students in the school and have taken the degree of Ph.B. in course, in the year under which their names appear. With these are placed the names of graduates of other institutions who have in the same year received either the degree of Ph.B., or other higher degrees after pursuing studies, wholly or in part, in the Scientific School. The present occupation is given, so far as known, and on the right hand side of the page the present or permanent address. A star (*) prefixed to a name indicates death and a dagger (†) the class secretary. Persons who can furnish information appropriate to this catalogue are requested to write to the Secretary of the Sheffield Scientific School.

1852.

William Phipps Blake, A.M., Mill Rock, New Haven, Conn.
Mining Engineer, formerly Professor of Geology and Mining in the University of California.

William Henry Brewer, A.M., Ph.D., New Haven, Conn.
Professor of Agriculture, Sheffield Scientific School of Yale College.

George Jarvis Brush, A.M., New Haven, Conn.
Professor of Mineralogy and Director of the Sheffield Scientific School of Yale College.

William Jarvis Craw, Rowayton, Conn.
Oyster Grower.

William Arthur Shepard, A.M., Ashland, Va.
Professor of Natural Science and Chemistry, Randolph Macon College.

Ludwig Stadtmueller, New Haven, Conn.
Mineralogist and Dealer in Minerals.

Mason Cogswell Weld, Closter, Bergen Co., N. J.
Agriculturalist.

*George Washington Weyman, Ph.D., *1864.

1853.

·les Francis Chessman.	———
iam Batcheler Cochran.	———
iel Farrand Henry, Patent Expert and Solicitor.	Detroit, Mich.
amin Cutler Jillson, M.D., Ph.D., Professor of Zoology and Geology, Illinois Industrial University.	Champaign, Ill.
lliam Henry McRuer.	*1858.
ert Ezekiel Palen, M.D.	———
·rt Bowman Rogers. Civil Engineer, C. P. R. R. Survey, Mountain Division via. Winnipeg, Canada.	Winnipeg, Canada.

1854.

phen Lyford Crosby.	*1875.
ın Antonio Duvillard,	*1865.
hael Espinosa.	———
nzo Tyler Mosman, Assistant on U. S. Coast and Geodetic Survey, Washington, D. C.	Beverly, Mass.
id Ball Parsons.	———
rge Bowen Pierson.	———
ian Terry, A.B.	———

1855.

derick Hoyt Allen,	New Haven, Conn.
ıes Clarence McGregor,	Cincinnati, O.
Moore.	———
vell W. St. John, Actuary, Ætna Life Insurance Co.	Hartford, Conn.
·fre Vengohechea,	Santa Martin, New Grenada.
·rge D. Walcott,	Detroit, Mich.
·mas A. Wilcox,	Cedar Rapids, Iowa.

1856.

nand Boisblanc,	New Orleans, La.
eph Hill Brinton, Farmer and Quarryman.	Thornburg, Chester Co., Pa.
han Smith Bronson.	———
eon Horace Candee,	P. O. Box 21, Lowell, Mass.
stus Lyman DeForest, A.B., A.M.,	Watertown, Conn.
·rge Franklin Fuller,	Brighton, Mass.
·rge W. Lyle.	———

Lewis Peck Morehouse, 4717 Kenwood Ave., Chicago, Ill.
Tax Department Illinois Central R. R. and Secretary of the Western Society of Engineers.

Isidore Plata, Bogota, New Grenada.

Henry Martyn Seely, M.D., A.M., Middlebury, Vt.
Professor of Chemistry, Middlebury College.

*Matthew Watson, *1864.

Lewis Williams, Cleveland, O.

1857.

Edward Curtis. ——

John King Gilbert, Concordia, La.

*Charles Harger, *1875.

Edmund Perlee Herrick, Athens, Pa.

Alexander Hamilton Kent, New Orleans, La.

*David Bigum Martin, *1869.

G. Harrison Meade, Little Rock, Ark.

Wm. Henry Pike, Mattituck, Suffolk Co., N. Y.
Farmer and Surveyor.

*Selden Silliman Richards, *1883.

1858.

*Demetrius Thomas Arosmena, *1880.

George Frederic Barker, M.D., 3909 Locust st., Philadelphia, Pa.
Professor of Physics, University of Pennsylvania.

John Marcus Blake, 1 York Square, New Haven, Conn.
Photographer on Wood.

Julius Gay, A.B., Farmington, Conn.
Treasurer Farmington Savings Bank.

*Henry Kelley Hodges, *1879.

Horace Kendall King, LL.B., Tully, Onondaga Co., N. Y.
Attorney at Law.

Charles Stewart Kittridge, C.E., M.D., Nashua, N. H.

Fidel Pombo, Bogota, New Grenada.

Alfred Perkins Rockwell, A.B., A.M., 3 Fairfield st., Boston, Mass.
Treasurer Great Falls Manufacturing Co.

*Edward Sackett, *1861.

*Orson Cowles Sparrow, A.B., M.D., *1877.

John Davenport Wheeler, New Haven, Conn.

1859.

Franklin Booth, M.D., East Windsor, Conn.

Henry Augustus DuBois, M.D., San Rafael, Marin Co., Cal.

William Buck Dwight, A.B., Poughkeepsie, N. Y.
Professor of Natural History and Curator of the Museum, Vassar College.

Alexis Wynns Harriott, A.B., Turk's Island, West Indies.

George Dallas Seely, Honesdale, Pa.
Assistant Examiner, Patent Office, Washington, D. C.

George Hazard Smith, New London, Conn.

Sutherland Douglas Twining, M.D., 306 West Indiana st., Chicago, Ill.

1860.

Clifford Coddington. ———

Alfred William Hearn, M.D. ———

Edwin Hutchinson, M.D., 224 Genesee st., Utica, N. Y.

*Edward Augustus Manice, A.B., *1877.

Joseph Addison Rogers, C.E. ———

Walter Scott Sheafer, Pottsville, Pa.
Mining Engineer.

1861.

Oscar Dana Allen, Ph.D., New Haven, Conn.
Professor of Chemistry and Metallurgy, Sheffield Scientific School of Yale College.

Hezekiah Bissell, American Society of Civil Engineers, New York City.
Master of Maintenance of Way, Boston and Maine R. R., Salem, Mass.

Charles W. Burrage, Portland, Oregon.
Civil Engineer.

José Filomenos Cifuentes, Copiapo, Chili.

Salomé Martinez, Matanzas, Cuba.

Gideon Emmett Moore, Ph.D., 69 Liberty st., New York City.
Chemist, New York City.

Carrington Howard Raymond. ———

Joshua Sands. ———

Eugene Schuyler, A.B., Ph.D., LL.D., 1024 17th st., Washington, D. C.

Arthur Williams Wright, A.B., Ph.D., New Haven, Conn.
Professor of Molecular Physics and Chemistry, Yale College.

1862.

Charles Henry Bunce, Hartford, Conn.
Civil Engineer and City Surveyor.

Juan Griñan, Santiago de Cuba, Cuba.

Clarence King, 18 Wall st., New York City.
Mining Engineer and late Director U. S. Geological Survey.

Daniel Smith Mead, Greenwich, Conn.
Attorney at Law and Judge of Probate Court.

Samuel Parsons, Jr., 76 Bible House, New York City.
Landscape Architect.

1863.

Josiah Willard Gibbs, A.B., Ph.D., New Haven, Conn.
Professor of Mathematical Physics, Yale College.

Watson Andrews Goodyear, New Haven, Conn.
Civil and Mining Engineer.

Arnold Hague, Washington, D. C.
Geologist, U. S. Geological Survey.

Landon Ketchum. ——

*Ignatio Megia, *1865.

1864.

Charles Bill, Springfield, Mass.

Robert Long Brownfield, 103 N. Water st., Philadelphia, Pa.
Brownfield & Co., Commission Merchants.

Beverly Scott Burton, Ph.D., Munich, Bavaria.

Edwin Wallace Carpenter, Beverly, Cal.
Secretary Firemen's Fund Insurance Co.

Ellsworth Daggett, Box 1088, Salt Lake City, Utah.
Mining Engineer.

Frederick Farnsworth, M.D., 226 Walnut st., Philadelphia, Pa.
Petroleum Refiner.

Albert Hiller Roffe, 11 Broomfield st., Boston, Mass.
A. H. Roffe & Co., Subscription Agency.

Henry Dyer Tiffany, Fox Homestead, Fox Corner, Station R, New York City.

Arthur Van Harlingen, M.D., 129 S. 15th st., Philadelphia, Pa.
Professor of Dermatology, Philadelphia Polyclinic.

1865.

William Henry Glenny, Buffalo, N. Y.
Merchant.

Charles Holt, 29 W. 23d st., New York City.
Henry Holt & Co., Publishers.

Francis Jedediah Leavens, Norwich, Conn.
Cotton Manufacturer.

Albert Parsons Massey, 1700 Wilson ave., Cleveland, O.
Mechanical Engineer.

Alexander Smith Palmer, Stonington, Conn.

Sanford Robinson, 320 Sansome st., San Francisco, Cal.
Civil Engineer.

Harry Rogers, Philadelphia, Pa.
Banker, Tradesmen's National Bank.

*Theron Skeel, C.E., *1878.

James Bennett Stone, C.E., Worcester, Mass.
Washburn Manufacturing Co.

Frederick Folger Thomas, A.B., Jerome via Prescott, Arizona.
Superintendent United Verde Copper Mines.

nuel Reading Throckmorton, A.B., A.M., *1880.

tin Van Harlingen, 415 Wyoming st., West Philadelphia, Pa.
Principal Assistant Engineer, Pennsylvania R. R., Reading, Pa.

1866.

rge Douglass Coit, Norwich, Conn.
Treasurer, Chelsea Savings Bank.

rian John Ebell, M.D. *1877.

rles Henry Gauss, Sedalia, Mo.

ford Linsly, 51 W. 10th st., New York City.
Artist.

ncis Englesby Loomis, A.B., Ph.D., Care of Prof. E. Loomis, New Haven, Ct.

exander Ufford McAllister, *1874.

rles Fraser McLean, A.B., Ph.D., New York City.
Attorney at Law.

n Jarvis Matthias, A.B., A.M., New Haven, Conn.
Shipping.

rles Greene Rockwood, Jr., A.B., Ph.D., Princeton, N. J.
Professor of Mathematics, College of New Jersey.

1867.

ney Giles Barbour, Burlington, Vt.
Professor of Civil Engineering, University of Vermont.

n Kennedy Beeson, Uniontown, Pa.

·ed Caldwell, Wheeling, West Va.
Attorney General of West Virginia.

nuel Hosmer Chittenden, C.E., Corcoran Building, Washington, D. C.
Chittenden Bros., Civil Engineers and Contractors.

·man Stewart Ferry, *1869.

ter Houtz Grove, *1875.

ert Michael Grove, Danville, Pa.
President, Grove, Grier & Co., Iron and Steel Boiler and Ship Plates.

rles Henry Hubbard, Hartford City, Ind.
Spoke Manufacturer, Hartford City, Ind.

liam Gilbert Mixter, New Haven, Conn.
Professor of Chemistry, Sheffield Scientific School of Yale College.

liam Harmon Niles, Boston, Mass.
Professor of Geology, Massachusetts Institute of Technology.

liam North Rice, A.B., Ph.D., Middletown, Conn.
Professor of Geology, Wesleyan University.

rles Joseph Sheffield, Cleveland, Ohio.

ney Irving Smith, New Haven, Conn.
Professor of Comparative Anatomy, Sheffield Scientific School of Yale College.

niel Halsey Wells, C.E., Hartford, Conn.
Actuary and Assistant Secretary, Connecticut Mutual Life Insurance Co.

Joseph Thompson Whittelsey, Box 833, New Haven, Conn.
Luther Hodges Wood, M.D., 429 Lawrence st., Denver, Col.

1868.

Wellington Miles Andrew, Orange, New Haven Co., Conn.
Farmer.

Leonard Strong Austin, Stratford, Conn.
Chemist, Germania Lead Works, Salt Lake City, Utah.

George Franklin Bailey, Rutland, Vt.
Locating Engineer, B. & M. st. R. R., Lincoln, Neb.

Samuel Atkins Barbour, Aspen, Col.
Superintendent, Spar Consolidated Mine.

Frederick Converse Beach, 361 Broadway, New York City.
Editor and President, N. Y. Amateur Photographic Society.

James DeTrafford Blackstone, Norwich, Conn.
Manufacturer.

†Eugene Stuart Bristol, 65 Elm st., New Haven, Conn.
Treasurer, U. S. Pin Co.

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Attorney at Law.

Henry Marchant Dudley, Whitinsville, Mass.

Henry Turner Eddy, A.B., C.E., Ph.D., Cincinnati, Ohio.
Professor of Mathematics and Astronomy, University of Cincinnati.

Barton Darlington Evans, West Chester, Pa.
Editor.

Edward Forsyth Finney, City Hall, St. Louis, Mo.
Chief Clerk, Board of Public Improvements.

James Fowler, Duluth, Minn.
Lake Superior Elevator Co.

James Terry Gardiner, Albany, New York.
Director of New York State Survey.

Frank Morton Guthrie, 113 Vine st., Cincinnati, Ohio.
General Agent, Grand Rapids & Indiana R. R.

John Corey Hersey, U. S. Custom House, New York City.
Entry Clerk, Naval Office.

Rev. George Anson Jackson. ——

Joseph Scott McKell. Chillicothe, Ohio.
Importer of China, Glass and Queensware.

Charles Kinney Needham, C.E., Louisville, Ky.

Frederick George Noonan, Milwaukee, Wis.
Commission Merchant.

Lyman Bradley Parshall, Farman Village, N. Y.
Stock Raising, Kansas.

William Wallace Redfield, St. Paul, Minn.

Alexander Renick, Chillicothe, Ohio.
Vice-President, First National Bank.

*Joseph Perkins Rockwell, *1885.

*Louis Bridge Stone, *1871.

Samuel Swift, M.D., Yonkers, N. Y.

Henry Shaler Williams, Ph.D., Ithaca, New York.
Professor of Palæontology, Cornell Univ., and Assistant Geologist U. S. Geol. Survey.

1869.

William Greene Abbot, Hartford, Conn.
Secretary of the Connecticut Mutual Life Insurance Co.

Wilbur Olin Atwater, A.B., Ph.D., Middletown, Conn.
Professor of Chemistry, Wesleyan University.

William Richardson Belknap, Louisville, Ky.
W. B. Belknap & Co.

Roman Augustus Bissell. Detroit, Mich.
Assistant Treasurer and Cashier of Riverside Storage Co.

Charles Augustus Brinley, 247 S. 16th st., Philadelphia, Pa.
Superintendent of Sugar Refinery.

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Andrew Dwight Chidsey, Easton, Pa.
Manufacturer of Paints.

Clarence Marcellus Clarke, 501 Stanton Place, Washington, D. C.
Civil Engineer.

Frederick Smillie Curtis, Brookfield Centre, Fairfield Co., Conn.
Teacher.

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City Engineer, Department of Public Works.

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Hornblower & Marshall, Architects.

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Mining Engineer.

*Edward Whiting Johnson, *1878.

Joseph Goodhue Kendall.

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*Charles Byron Koon, *1885.

Houston Lowe, Dayton, Ohio.
Lowe Bros., Paints and Glass.

Edward Thomson Nelson, A.B., Ph.D., Delaware, Ohio.
Professor of Natural History, Wesleyan University.

Henry Hoyt Perry, Southport, Conn.
Insurance Agent.

George Henry Perkins, A.B., Ph.D., Burlington, Vt.
Professor of Natural History, University of Vermont.

Charles Henrique Pope, 515 N. Main st., St. Louis, Mo.
Deere, Mansur & Co.

Joseph John Skinner, C.E., Ph.D., Ithaca, N. Y.

Robert Schuyler Van Rensselaer, Uniontown, Fayette Co., Pa.
Civil Engineer.

Charles Alva Weed, 83 Court st., Binghamton, N. Y.
Wholesale Manufacturer of Clothing.

William Robert White, Philadelphia, Pa.

Horace Franklin Whitman, 12th & Market sts., Philadelphia, Pa.
Stephen Whitman & Son.

Willard Wendell Wight, Natick, Mass.
Civil Engineer.

†Frederick Everett Willits, Glen Cove, Queens Co., L. I.
Farmer.

1870.

James Whitin Abbott, A.B., Lake City, Col.
Mining Engineer.

Henry Moore Bailey, Louisville, Ky.

Charles Thurston Ballard, Louisville, Ky.

Thomas Gray Bennett, New Haven, Conn.
Vice-President of Winchester Repeating Arms Co.

Townshend Stith Brandegee, Berlin, Conn.
Civil Engineer.

Daniel Seymour Brinsmade, Birmingham, Conn.
Engineer Ousatonic Water Co.

Charles Peter Brooks, Salt Lake City, Utah.
Civil Engineer and U. S. Deputy Mineral Surveyor.

Thomas Elwood Calvert, Newtown, Pa.

*Frederick Hosea Churchill, LL.B., *1881.

Dorr Clarke, Green Bay, Wis.
Stock Raising, Spearfish, Dakotah.

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Civil Engineer, Ellsworth Luther & Co.

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William Alfred Hinds, Community, Madison Co., N. Y.
Secretary of Oneida Community, limited.

Edward Van Buren Hoes, Chicago, Ill.
Union National Bank.

William Rufus Hopson, Bridgeport, Conn.
Wholesale Grocer.

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Augustus Washington Littleton, Quincy, Ill.
Superintendent of Quincy Gas Co.

*Francis Asbury Lowe, *1883.

†William Dennis Marks, C.E., Philadelphia, Pa.
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Arthur Woods Rice, New Britain, Conn.
City Engineer and President of Water Board.

George Douglass Roseberry, Pottsville, Pa.

Alfred Stanton, Sligo, Md.

Clarence Augustus Warren, 611 W. Main st., Louisville, Ky.
Merchant.

John George Watson, Ayr, Canada.
Superintendent Watson Manufacturing Co., Agricultural Implements.

1871.

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Assistant, New York State Survey.

Edwin Faxon Bacon, Newark, N. Y.

Luther White Burt, 330 Main st., Hartford, Conn.
Civil Engineer.

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Chittenden Bros., Engineers and Contractors.

Russell Wheeler Davenport, Nicetown, Philadelphia, Pa.
Superintendent of Midvale Steel Co.

William Cecil Durand, Milford, Conn.
Farming.

Charles Hascall Dwinelle, Berkeley, Alameda Co., Cal.
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First Assistant City Engineer.

Charles Henry Greene, Cincinnati, Ohio.
President of the Standard Nail and Iron Co.

*Charles Woodford Griswold, *1878.

Bernard James Harrington, A.B., Ph.D., Montreal, Canada.
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Assistant U. S. Attorney, District of N. J.

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George Granville Lobdell, Wilmington, Del.
Lobdell Car Wheel Co.

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Professor of Civil Engineering, Lehigh University, Acting Assistant U. S. Coast and Geodetic Survey.

Alfred Lewis Moore, Fond du Lac, Wis.
Vice-President of La Belle Wagon Works.

*Daniel Hobart Pierpont, *1874.

*Ferdinand Eugene Powell, *1872.

John Franklin Quigley, Niagara Falls, N. Y.
Manufacturer of Wood Pulp.

Frederick Lockwood Sanford, New Haven, Conn.

†Henry Bradford Sargent, New Haven, Conn.
Sargent & Co., Manufacturers of Hardware.

Edward Clinton Terry, Hartford, Conn.
Manufacturer.

Henry Degen Ziegler, 218 S. Front st., Philadelphia, Pa.
Hannis Distilling Co.

1872.

Jacob Jackson Abbott, C.E., Lake City, Huisdale Co., Col.
Civil and Mining Engineer.

James Peter Bogart, New Haven, Conn.
Engineer, Connecticut Shell Fisheries Commission.

Wheeler DeForest Edwards, A.B., LL.B. ——

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*George Wesson Hawes, Ph.D., *1882.

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*Daniel Wardwell Wardwell. *1878.

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City Engineer.

Richard Chapman Weldon, Ph.D. ——

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Broker.

Thomas Wallace Wright, A.M., C.E., Galt, Canada.

1873.

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Fillmore Cogswell, Marbledale, Conn.

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William Allen Cowles, Patent Office, Washington, D. C.

*Charles Adams Cragin, *1878.

Neville B. Craig, A.B. Pittsburgh, Pa.

Robert J. Currey, Dixon, Solano Co., Cal.
Wheat and Stock raising.

Francis Urquhart Downing, A.B., D.E.. Columbus, Ga.
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Harry Taylor Gause, Wilmington, Del.
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W. R. Grace & Co., 142 Pearl st.

William Hampton Jenks, D.E. Brockville, Jefferson Co., Pa.
Iron Founder and Machinist.

Charles Rockwell Lanman, A.B. Ph.D., Cambridge, Mass.
Professor of Sanskrit, Harvard University.

George Christopher Moore, New Haven, Conn.
Draughtsman, F. C. & A. E. Rowland.

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Edgar Camp Savage, Meriden, Conn.
Meriden Britannia Co.

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*Louis Rodney Taylor, *1882.

Edward Allen Wilson, A.B. ——

Henry Goodrich Wolcott, LL.B., Fishkill-on-Hudson. N. Y.

1874.

Henry Prentiss Armsby, Ph.D., Madison. Wis.
Professor of Agricultural Chemistry, University of Wisconsin.

Nathan Edward Beckwith, New Haven. Conn.
Farmer, San Jose, Cal.

Jacob Alexander Bezjian, Aintab, Syria.
Professor of Physical Science, Central Turkey College.

Charles Cook Brewster, Buffalo, N. Y.
Northrop, Mathews & Co., Publishers, 179 Washington st.

Edward Brush, 116 Pearl st., N. Y.
Empire Refining Co.

Arthur Bucklin Claflin, 73 High st., Boston, Mass.
Merchant, Newtonville, Mass.

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Augustus Hjalmar Edgren, Ph.D., Sweden.
Professor of Sanscrit, University of Lund.

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Broker, Soutter & Co.

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Mechanical Engineering, New Haven, Conn.

Edwin Horace Forbes, Holyoke, Mass.
Principal of the Holyoke High School.

*LeRoy Gale, M.D., *1883.

Jacob Houtz Grove. Danville, Pa.
Manufacturer of Pig Iron, Fredericksburg, Pa.

Vincent Gilpin Hazard, Wilmington, Del.
Draughtsman, Pusey Jones & Co.

Frazier Davenport Head, 79 Sachem st., New Haven, Conn.
Counselor at Law, 1455 Q st., Washington, D. C.

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Allen Brewer Howe, Ph.D., Troy, N. Y.
Chemist. Howe & Co.

Henry Hun, M.D., 33 Elk st., Albany, N. Y.
Lecturer on Nervous Diseases, Albany Medical College.

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Henry Jarvis Kellogg, Waterbury, Conn.
Assistant City Engineer.

Charles Hittell Killinger, LL.B., Lebanon, Pa.
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*Beverly Livingstone, M.D., *1883.

Joseph Taplin Lovewell, A.B., Ph.D. Topeka, Kan.

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Chief Engineer of the Morse Bridge Co.

George Smith Needham, LL.B., Richmond, Ind.

H. G. Newhall, San Francisco, Cal.
Attorney at Law.

Eugene Ernest Osborn, LL.B., Ishpenning, Mich.
Attorney at Law..

Richard Deane Arden Parrott, Orange Co., N. Y.
Manufacturer of Pig Iron, Greenwood Iron Works.

Claudius Victor Pendleton, Yantic, Conn.
Civil Engineer.

Walter Brewster Platt, M.D., F.R.C.S., 165 Park ave., Baltimore, Md.
Demonstrator of Surgery, University of Maryland, Surgeon to Bay View Hospital

George Coffin Power, 309 Sansome st., San Francisco, Cal.
Superintendent and Engineer, Newhall Land and Farming Co., Santa Maria, Cal.

William Spencer Pratt. ———

†William Henry Reynolds, New Haven, Conn.
Reynolds & Co.

William Rockwell, LL.B., Equitable Building, 120 Broadway, New York City.
Attorney at Law, Rockwell, Pearson & Osborne.

William Arthur Rogers, Higgins Block, Cincinnati, Ohio.
Senior member of Rogers, Brown & Co., Pig Iron Manufacturing.

John Muirhead Stewart, Peekskill, N. Y.
Civil Engineer, Aqueduct Commission, Dobbs Ferry, N. Y.

Francis Hill Stillman, 470 Grand st., New York City.
Manufacturer of Hydraulic Machinery, Watson & Stillman.

*William Richardson Upham, M.D., *1882.

Simeon Harrison Wagner, LL.B., 70 Church st., New Haven, Conn.
Attorney at Law.

*John Charles Weber, *1881.

Marcelon Sylvester Wilson. ———

1875.

Charles Henry Alling, Birmingham, Conn.
Woolen Manufacturer.

Launcelot Winchester Andrews, Ph.D., F.C.S., Ames, Iowa.
Professor of Theoretical and Analytical Chemistry, Iowa Agricultural College.

Moses Bradstreet Bradford, 335 Jersey st., Buffalo, N. Y.
Barnes, Hengerer & Co

John Gilbert Bramley, LL.B., Jordan, Onondaga Co., N. Y.
Attorney at Law and Civil Engineer.

George Loomis Brownell, 16 Union st., Worcester, Mass.
Manufacturer of Machinery.

Amos Avery Browning, LL.B., Norwich, Conn.
Browning & Crandall.

Charles Stuart Bunce, Glastonbury, Conn.

Francis Taylor Chambers, Philadelphia, Pa.
Harding & Chambers.

Edward Benjamin Chandler, San Antonio, Texas.
Loan and Real Estate Agent.

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Professor of Physiological Chemistry, Sheffield Scientific School of Yale College.

William Alexander Christie, Newport, R. I.

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Chambers McKibbin Craig, Dublin, Ga.
Civil Engineer.

James Cunningham, 327 Sansome st, San Francisco, Cal.
Cunningham, Curtis & Welch, Wholesale Stationery.

Charles William Fenn, Cleveland, Ohio.
Assistant Engineer, L. S. & M. S. R. R.

*Charles Hamilton Fox, *1880.

*James Freeland, *1880.

Luther Henry Gager, Palmer, Mass.
Civil Engineer, Flynt Building & Construction Co.

Livingston Gifford, LL.B., 297 Bergen av., Jersey City, N. J.
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Vice-President of the Perth Amboy Terra Cotta Co.

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Milling.

Alfred Pell Haven, N. Y. World office, New York City.
Reporter, New York World.

Charles Hildebrand, D.E., Hartford, Conn.
Assistant Actuary, Connecticut Mutual Life Insurance Co.

William Read Howe, LL.B., Orange, Essex Co., N. J.
Counsellor at Law.

Thomas Douglas Hoxsey, Paterson, N. J.
Paymaster, U. S. N.

Julian Kennedy, Pittsburg, Pa.
Manager of the Lucy Furnaces.

Edward Austin Kent, A.A.I.A., 274 Delaware av., Buffalo, N. Y.
Architect.

George Reinard Kleeberger, San Jose, Cal.
Professor of Natural History, State Normal School.

*Wells Cushman Lake, *1876

Charles Purdy Lindsley, M.D., 15 Elm st., New Haven, Conn.

Blanchard Lynde, M.D., Milwaukee, Wis.

Clarence Fake McMurray, Hartford, Conn.
McMurray & Stoughton, Manufacturers of Power Transmitting Machinery.

Burton Mansfield, LL.B., 4 Law Chambers, New Haven, Conn.
Attorney at Law.

John Charles Olmsted, Brookline, Mass.
Landscape Architect.

Edward Day Page, 66 Leonard st., New York City.
Faulkner, Page & Co., Dry Goods Commission.

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*Dwight Edward Pierce, C.E., *1885.

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Mechanical Engineer.

Rev. Walter Coe Roberts, Ansonia, Conn.
Rector of Christ Church.

Richard Sharpe, Jr. Wilkesbarre, Pa.
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Wm. Wharton, Jr. & Co., Builders of Street Railways and Railway Supplies.

Alfred Newton Wheeler, LL.B., New Haven, Conn.

Henry Stacy Whipple, Birmingham, Conn.
Civil Engineer, Derby Gas Co.

Edward Luther White, Bridgeport, Conn.
Paper Box Manufacturer.

George Horace Wilcox, Meriden, Conn.
Meriden Britannia Co.

Kenjiro Yamagawa, Tokio, Japan.
Professor of Physics, University of Tokio.

1876.

*David Root Alden, *1882.

Halsey Warren Allen, Jersey City, N. J.

Eveline Marcelon Andrews, Moosup, Windham Co., Conn.
Architect.

Charles *Eben Bacon*, Middletown, Conn.

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Engineer C. St. P. & O. R. R.

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Stock Raising.

Will Browning, M.D., 54 Lefferts place, Brooklyn, N. Y.

Walter Cleveland Butler, Lugonia, San Bernardino Co., Cal.
Fruit Raising.

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Assistant Superintendent of Bridges and Buildings, Missouri Pacific R. R., Denison, Texas.

John Henry Chapman, 44 Mason Building, Kilby st., Boston, Mass.
Architect.

Sidney Williams Clark, 799 Asylum st., Hartford, Conn.
W. N. Pelton & Co., Dry Goods.

John Moffat Cunningham, Organ, New Mexico.
Mining Engineer.

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Frederick Perkins Dewey, National Museum, Washington, D. C.
Curator of Metallurgy.

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Civil Engineer.

Stanly Forbes, 214 Sansome st., San Francisco, Cal.
Civil Engineer.

Edward Livingston Ford, Youngstown, Ohio.
General Superintendent of the Youngstown Steel Co.

Porter Dwight Ford, Tacony, Pa.
Supervisor, Division C, New York Division of the Pennsylvania R. R. Co.

Edward Jasper Francke, 120 Front st., New York City.
Francke Sons & Co., Sugar Commission Merchants.

Robert Jackson Gibson, M.D., Fort Winfield Scott, San Francisco, Cal.
First Lieutenant and Assistant Surgeon U. S. A.

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Randell Hunt, St. Paul, Minn.
Civil Engineer, Fargo, Dakota T.

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Rev. Solomon Kohn. ———

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Copake Iron Works, Copake, N. Y.

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H. M. Newhall & Co.

n Robert Paddock. Brick Church P. O., Orange, N. J.
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vard Larned Ryerson, 18 Milwaukee av., Chicago, Ill.
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illiam Babcock Sawyer, *1880.

rles David Seeberger, 40 Lake st., Chicago, Ill.
Seeberger & Co., Hardware.

lrew Gilbert Sheak, 96 Washington st., Binghamton, N. Y.
Sheak, Rogers & Co.

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mas Ewing Sherman, A.B., St. Louis, Mo.
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Chemist.

derick William Vanderbilt, Grand Central Depot, New York City.
Director N. Y. C. & H. R., L. S. & M. S., Ch. & N. W. Railways, etc.

rles Williams VanVleck, Gainesville, Ga.

rles Alexander Watson, Box 924, Meriden, Conn.

derick Wood, Norwalk, Conn.
Assistant Engineer, Penna. R. R., 233 S. 4th S., Philadelphia, Pa.

mas Yeatman, St. Louis, Mo.

1877.

lliam Whittlesey Abbott, Youngsville, Pa.
Principal of High School, Sheffield, Mass.

lliam Henry Backus, Riverside, San Bernardino Co., Cal.
Orange and Raisin Grower.

rge Henry Bartlett, New Britain, Conn.

rris Burke Belknap, Louisville, Ky.
W. B. Belknap & Co., Hardware.

nard Berens, M.D., 1910 Arch st., Philadelphia, Pa.

Arthur Lewis Betts, Norwalk, Conn.
Engineer, Kingston Water Works.

Frank Lewis Bidwell, Kansas City, Mo.
Civil Engineer, Missouri Pacific R. R.

James Henry Brewster, LL.B., Detroit, Mich.
26 Newberry Building.

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Judson Amos Doolittle, Cheshire, Conn.
Engineer Woodlawn Cemetery, Woodlawn, N. Y.

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Superintendent of Bridges, Department of Public Works, City Hall, Philadelphia, Pa.

Joachim John Francke, 220 Front st., New York City.
Sugar Merchant, Havana, Cuba.

William Edgar Gard, Meriden, Conn.
Secretary and Treasurer of the Meriden Bronze Co.

John Elisha Morpeth Hall, LL.B., 167 Broadway, New York City.

William Stanley Hine, 150 Broadway, New York City.
Lithographer and Publisher.

Walter Holcomb, LL.B., 591 Lincoln av., St. Paul, Minn.

Horace Cobb Howard, Townshend, Vt.

Joseph Paxson Iddings, Orange, N. J.
Assistant Geologist, U. S. Geological Survey, Washington, D. C.

Charles Maples Jarvis, East Berlin, Conn.
Vice-President and Chief Engineer of the Berlin Bridge Co.

Lawrence Kneeland, LL.B., 97 Bedford av., Brooklyn, N. Y.
Attorney at Law, 66 Wall st., New York.

Elijah Thien Foh Laisun, Shanghai, China.
4 Garden Villa, Hongken.

Francis Cooper Lawrance, Jr., LL.B., 26 E. 37th st., New York City.

Alton Winslow Leighton, M.D., 117 Elm st., New Haven, Conn.

Charles James Luck, Rouse's Point, N. Y.
Foreman, Chicago City R. R. Co., 2020 State st., Chicago, Ill.

Ferrier John Martin, Box 3087, New York City.
Commission Merchant, 114 Worth st., New York.

Charles Knox Mixter, Rock Island, Ill.
With the Rock Island Stove Co.

James Blair Murray, 233 Prospect st., Norwich, Conn.

Samuel Lewis Penfield, New Haven, Conn.
Instructor in Mineralogy, Sheffield Scientific School of Yale College.

Willard Nourse Pratt, Elmira, Chemung Co., N. Y.
Wholesale Grocer, 211 Baldwin st.

Nathanael Chapin Ray, Omaha, Neb.
Civil Engineer, Union Pacific R. R.

Francis Rawlinson Read, Hartford, Conn.

Lucius Waterman Robinson, 255 Ferry st., New Haven, Conn.
Superintendent of the Rochester Colliery, DuBois, Clearfield County, Pa.

Thomas Fitch Rowland, Jr., 199 Keap st., Brooklyn, N. Y.
Mechanical Engineer, Continental Works, Brooklyn.

James Alvin Scott, Wallingford, Conn.
U. S. Counsel at Manaos, Brazil.

William Thompson Sedgwick, Ph.D., Boston, Mass.
Professor of Biology, Massachusetts Institute of Technology.

Charles Dwight Smith, Plantsville, Conn.
Mechanical Engineer, H. D. Smith & Co., Carriage Hardware.

George Smith, New Haven, Conn.

Thomas Alexander Smith, Ph.D., Beloit, Mich.
Professor of Mathematics and Astronomy, Beloit College, Michigan.

Walter Snowden Smith, 118 Broadway, Cincinnati, Ohio.
Mining Engineer, Tucson, Arizona.

Henry Ling Taylor, M.D., 100 W. 53d st., New York City.

Arthur John Tenney, M.D., Branford, Conn.

Allen Mason Thomas, M.D., Wickford, R. I.
Physician in Chief, State Emigrant Hospital, Ward's Island, N. Y.

William Gilman Thompson, M.D., 49 E. 30th st., New York City.

John Abeel Weekes, LL.B., Oyster Bay, Queen's Co., New York.
Attorney at Law, 58 Wall st., New York.

Horace Lemuel Wells, New Haven, Conn.
Instructor in Chemistry, Sheffield Scientific School of Yale College.

James Harold Wickersham, Lancaster, Pa.
Manager Inquirer Printing Co.

Albert Daniel Wilson, Cerro, Taos Co., New Mexico.
Stock Raising.

George Leverett Wilson, C. E., Danielsonville, Conn.
Assistant City Engineer, St. Paul, Minn.

Edwin Young, LL.B., 233 State st., Albany, N. Y.
Attorney for the Delaware & Hudson Canal Co.

1878.

William Day Allen, 251 Lake st., Chicago, Ill.
Wholesale Rubber Goods.

Seymour Landon Alvord, West Winsted, Conn.
Superintendent of the Empire Knife Co.

John Pomeroy Bartlett, LL.B., 39 W. Main st., New Britain, Conn.
Mitchell & Hungerford.

*John Luis Blackmore, *1881.

Edward Everett Brewster, West Cornwall, Litchfield Co., Conn.
Chemist, Menominee Mining Co., Iron Mountain, Mich.

Fayette Williams Brown, LL.B., Yonkers, N. Y.

William Tyler Browne, M.D., Lisbon, Conn.

Lucien Lowber Burrows, Decatur, Ill.
Secretary and Treasurer of Crane Roller Skate Co.

Charles William Canfield, 1321 Broadway, New York City.
Agent of the New England Granite Works.

William Grover Chapin, Somers, Conn.
Draughtsman, Joseph Edwards & Co., 414 Water st., New York City.

Robert Williams Chapin, LL.B., New London, Conn.
Mills Building, New York City.

†Charles Samuel Churchill, 257 Franklin st., New Haven, Conn.
Assistant Engineer, Reading & Pottsville R. R., Pottsville, Pa.

Samuel Fessenden Clarke, Ph.D., Williamstown, Mass.
Professor of Natural History, Williams College.

Walter Linsley Cowles, Youngstown, Ohio.
Assistant Engineer, Morse Bridge Co., Youngstown, Ohio.

Augustus James Emery, D.E., 107 Jerolemon st., Brooklyn, N. Y.
Mechanical Engineer, 155 Broadway, New York City.

Granger Farwell, 3342 Forest av., Chicago, Ill.
J. H. Pearson & Co., Lumber Merchants.

Oswin Hart Doolittle Fowler, LL.B., Wallingford, Conn.

Cadmus Zaccheus Gordon, LL.B., Brookville, Jefferson Co., Pa.

Leonard Vassall Greene, Norwich, Conn.

Ralph Augustus Harman, 631 Euclid av., Cleveland, Ohio.
Assistant Manager of the Cleveland City Forge and Iron Co.

Walter Tillman Hart, New Britain, Conn.

George Stewart Hegeman, LL.B., 111 W. 34th st., New York City.
Merchant, 1321 Broadway, New York City.

†Charles Betts Hillhouse, 409 Produce Exchange Building, New York City.
Grain Merchant.

Robert Samuel Hulbert, West Winsted, Conn.
Manufacturer.

Thomas Mastin Jacks, Jr., Helena, Ark.
Merchant and Planter.

Frederick Beckwith Jillson, Whitehall, N. Y.
N. Y. & Lake Champlain Transportation Co.

Edward Charles Le Bourgeois, Convent P. O., St. James Parish, La.
Planter.

*George Webb Mason, *1881.

William James Perry Moore, H. R. Worthington, Box 2227, New York City.
114 Queen Victoria st., London E. C., England.

Frank Turner Morehead, Box 2227, New York City.
Iron Manufacturer, Pittsburg, Pa.

*George Henry Potts, *1881.

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Charles Theodore Richmond, Springfield, Mass.
U. S. Deputy Collector of Internal Revenue, North Adams, Mass.

Edward Kilbourn Roberts, M.D., 244 Grand st., New Haven.

Edward Hubbard Russell, Park City, Utah; C. A. Stetefelt, 63 B'way, N. Y. City.
Secretary and Superintendent of the Bullionville Smelting Co., Bullionville, Lincoln Co., Nevada.

Edward Herndon Smith, Urbana, Champaign Co., Ill.
J. H. Pearson & Co., Lumber Merchants, Chicago, Ill.

William Annin Vliet, Cleveland, Ohio.
Vliet, Nutt & Co., Petroleum Refiners.

Ebin Jennings Ward, C.E., Chicago, Ill.

Edmund Beecher Wilson, Ph.D., Bryn Mawr, Pa.
Professor of Biology, Bryn Mawr College.

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Broker, N. Y. Stock Exchange.

1879.

†Harry Washington Asher, LL.B., 157 Church st. New Haven, Conn.
Driscoll & Asher.

William Montgomery Atwater, New Haven, Conn.
G. H. Gardner & Co., S. William st., New York City.

Nathaniel Terry Bacon, Syracuse, N. Y.
Civil Engineer, Solway Process Co.

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Real Estate.

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Charity Hospital, New York City.

Malcolm Booth, Cheshire, Conn.
Instructor in Mathematics, Episcopal Academy of Connecticut.

William James Comstock, Toledo, Ohio.
Munich, Bavaria.

Albert William Congdon, 104 Lefferts place, Brooklyn, N. Y.
Broker, 48 Broad st., New York City.

John Howard Cromwell, Cranford, N. J.
Mechanical Engineer.

George Clarence Egan, W. M. Egan, Chicago, Ill
Commission Merchant, San Diego, Cal.

Emerson Young Foote, LL.B., 113 Park st., New Haven, Conn

Norman Norton Fowler, LL.B., Holyoke, Mass
Hampden Paper Co.

John Currier Gallagher, LL.B., 69 Church st., New Haven, Conn.
Attorney at Law.

William Wesley Gibson, West Point, N. Y.
Second Lieutenant U. S. A. and Instructor at West Point Military Academy.

Frank Hanson Harrison, M.D., 331 W. 59th st., New York City.

Francis Hillhouse, 42 W. 24th st., New York City.
Hillhouse & Day, 411 N. Y. Produce Exchange.

Charles De Villiers Hoard, 94 Washington st., Chicago, Ill.
Handy & Co., Examiners of Land Titles.

Charles Perry Hull, 108 W. Bay st., Jacksonville, Fla.
Land Department Florida R. R. and Navigation Co.

Edward Hopkins Jenkins, A.B., Ph.D., New Haven, Conn.
Vice-Director and Chemist of the Connecticut Agricultural Experiment Station.

*John Jewett, *1883.

Alfred Dennis Lewis, Bridgeport, Conn.
Spring Perch Co.

George Walker Meeker, 95 Dearborn st., Chicago, Ill.
Coal Merchant, Meeker, Hedstrom & Co.

Kakichi Mitsukuri, Ph.D., Tokio, Japan.
Professor in the University of Tokio.

James Boyd Neal, A.B., M.D., Bloomsburg, Pa.
Medical Missionary, Presbyterian Board for Missions, Chee Foo, China.

Edward Delevan Nelson, 47 W. 25th st., New York City.
Motive Power Department, Penna. R. R., Altoona, Pa.

Walter Nordhoff, Alpine, Bergen Co., N. J.
Reporter, N. Y. Herald Office.

Frederick Wallace Paramore, 1626 Lucas Place, St. Louis, Mo.
Secretary and Treasurer of the S. W. Lumber Association.

Robert Wilson Patrick, LL.B., Box 437, Omaha, Neb.
Lindsay & Patrick.

Harold Roorbach, LL.B., Box 3410, New York City.
Publisher, 9 Murray st., New York City.

George Augustus Saunders, Avon, Hartford Co., Conn.
Secretary of the Climax Safety Fuse Co.

William Seth Silsby, 3 Terrace Row, Seneca Falls, N. Y.
Secretary of the Silsby Manufacturing Co.

Rufus Henry Skeel, Newburgh, N. Y.
Murray & Allen, Providence, R. I.

Herbert Eugene Smith, M.D., New Haven, Conn.
Professor of Chemistry and Dean of the Yale Medical School.

Thaddeus Henry Spencer, Holyoke, Mass.
Manager of the Wauregan Paper Co.

Isaiah Kidder Stetson, 116 Exchange st., Bangor, Me.
Ship Builder and Wholesale Ice Dealer.

Daniel Eddy Stone, 514 Euclid ave., Cleveland, Ohio.
United Brass Co.

*Arthur Stoddard Van Voorhis, LL.B., *1884.

John Thomas Waring, 81 Green st., New York City.
Waring Manufacturing Co.

Walter Watson, C.E. ——

Albert Lowry Webster, West New Brighton, Staten Is., N. Y.

Charles Seward Wilcox, Hamilton, Ontario, Canada.
Secretary of the Ontario Rolling Mill Co.

Walter Smith Williams, Evanston, Ill.
Reich & Williams, Lumber Merchants, Riverdale, Ill.

1880.

Daniel Sidney Appleton, 3 University Place, New York City.
Publisher.

Charles Rufus Ayres, Woodmont, Conn.
Bridgeport Brass Co., Bridgeport, Conn.

Charles Backus Ball, 1426 Pierce Place, Washington, D. C.
Civil Engineer.

Roger Clark Ballard Thruston, Ballard and Ballard Co., Lexington, Ky.
Assistant State Geologist, Kentucky Geological Survey.

Thomas Marcus Blakeslee, Ph.D. ———

Henry Banning Bradford, 1301 Delaware ave., Wilmington, Del.
Civil Engineer, B. & O. R. R., Chester, Pa.

Harry Osborne Carrington, 1167 Chapel st., New Haven, Conn.
Assistant in City Engineer's Office.

Joseph Arthur Chanute, Box 750, Leadville, Col.
Assayer and Chemist.

George Huntington Clark, Boonton, Morris Co., N. J.
Civil Engineer, Morris & Essex Division of D., L. & W. R. R., Hoboken, N. J.

Arthur Baylies Coffin, M.D., Edgarton, Mass.
Mt. Sinai Hospital, New York City.

Edward Allen Colby, 107 Orange st., Newark, N. J.
Superintendent Lamp Department, U. S. Electric Lighting Co., New York.

Frank McAlpine Collin, Benton Centre, Yates Co., N. Y.
Farmer.

Charles Mabie Crouse, Crouse Building, Syracuse, N. Y.
Real Estate.

Charles Thompson Dodd, 75 Colony st., Meriden, Conn.

Arthur Dodge, 28 Crown st., Meriden, Conn.
Meriden Britannia Co

Thomas Edward Doolittle, Atkinson, Holt Co., Neb.
Stock Raising.

Jacob Edward Emery, LL.B., Room 16 Exchange Building, New Haven, Conn.

George Edward Goodspeed, Box 1720, Boston, Mass.
Banker, Boston Safe Deposit & Trust Co., 87 Milk st.

John Warren Hardenbergh, 286 Barrow st., Jersey City, N. J.
Hudson County National Bank.

Louis Maynard Higginson, Eden, Concho Co., Texas.
Francis & Higginson.

Walter Hitchcock, M.D., Norwalk, Conn.

Theodore Lanahan Hooper, 2d and Frederick sts., Baltimore, Md.
Manufacturer of Cotton Duck, Rope, Twine, etc.

Colin Macrae Ingersoll, Jr., 85 Trumbull st., New Haven, Conn.
Civil Engineer, N. Y., N. H. & H. R. R.

Martin Edward Jensen, Norwich, Conn.
Instructor in Natural Science, Norwich Free Academy.

David Brown Lewis, Box 790, Yonkers, N. Y.
Assistant Engineer, New Croton Aqueduct.

Ernest Theophilus Liefeld, 36 Orchard st., New Haven, Conn.
Teacher.

Willey Solon McCrea, Chicago, Ill.
Grain and Provisions, 41 New Board of Trade.

John Moorhead, Jr., Pittsburgh, Pa.
Moorhead Bros. & Co., Iron and Steel Manufacturers.

Carl Eugene Munger, M.D., Waterbury, Conn.

Edward Butler Needham, Richmond, Wayne Co., Ind.
Manufacturer.

George Benjamin Phelps, Jr., M.D., Watertown, N. Y.
House Surgeon, New York Hospital, New York City.

Dwight Porter, Boston, Mass.
Instructor in Drawing, Massachusetts Institute of Technology.

Edward Freeman Porter, LL.B., Melville, Dakota.
Real Estate.

Edward Vilette Raynolds, M.L., D.C.L., 56 Montauk Block, Chicago, Ill.

Edward McNeil Rogers, Central City, Col.
Mining Superintendent.

George Bliss Rogers, 53 Norfolk st., Cambridge, Mass.
Real Estate.

†Edward Rupert Sargent, 51 Elm st., New Haven, Conn.
Sargent & Co., Manufacturers of Hardware.

William Bartlett Schofield, 301 Montgomery st., San Francisco, Cal.
Nevada Bank.

Henry Starkweather, Hartford, Conn.
Draughtsman, Ballou Manufacturing Co.

Adrian Rowe Wadsworth. Farmington, Conn.
Farmer.

William Candee Warren, 222 North st., Buffalo, N. Y.
Buffalo Commercial Advertiser.

Adolph Frederic Wehner, New Haven, Conn.
Smith & Sayre Manufacturing Co., 245 Broadway, New York City.

George Goodwin Williams, Glastonbury, Conn.
Manufacturing Chemist, J. B. Williams & Co.

1881.

Charles Francis Adams, Jessups, Md.
Cashier of the First National Bank, Colfax, Washington Territory.

Ethan Allen Andrews, Tarrytown, N. Y.
Johns Hopkins University, Baltimore, Md.

Edward Bailey, Jr., 31 S. Front st., Harrisburgh, Pa.
Chas. L. Bailey & Co., Chesapeake Nail Works.

†Frank Lewis Bigelow, New Haven, Conn.
Secretary of the Bigelow Co.

George Frederick Bosworth, Milford, Conn.
Architect, 847 Chapel st., New Haven, Conn.

Lester Paige Breckenridge, Westfield, Mass.

Charles Sheldon Burnham, 72 Mansfield st., New Haven, Conn.

Howard Field Chappell, 4340 Lake ave., Chicago, Ill.

Charles Manville Downs, M.D., 9 Wooster Place, New Haven, Conn.

John Slade Ely, M.D., 331 Fourth ave., New York City.

George Sherman Folsom, San Francisco, Cal.
Cashier of the Union Iron Works.

Seymour Francis Frasick, 48 Prospect st., Hartford, Conn.
Colt's Patent Fire Arms Manufacturing Co.

Albert Moses Gerstle, Youngstown, Ohio.

Henry Holbrook Gladding, New Haven, Conn.
Assistant City Engineer, City Hall.

William Loomis Griswold, M.D., Banksville, Fairfield Co., Conn.

Frederick Jonathan Hiller, Cohoes, N. Y.
American Hosiery Mills.

Samuel Higgins, Susquehanna, Pa.
General Foreman, Susquehanna Shops.

Blain Jamison, 248 Baronne st., New Orleans, La.
Cotton Manufacturer, 51 Carondelet st., New Orleans.

Owyang Keng, 95 Clinton Place, New York City.
Chinese Consulate.

Benjamin Franklin Koons, B.A., Sulphur Springs, Ohio.
Professor of Natural History and Principal of the Storrs Agricultural School, Mansfield, Conn.

Edmund Parker Lord, Renova, Clinton Co., Pa.
Power Department, Penna R. R. Co., Altoona, Pa.

Richard Becker Lyon, 395 Crown st., New Haven, Conn.
Teacher.

Silas Metzger, 23 Grove st., New Haven, Conn.
Secretary of the Metzger Rubber Co.

Edwin Kirtland Morse, Youngstown, Ohio.
Chief Engineer of the Morse Bridge Co.

Marcus Daty Munn, LL.B., 31 Washington ave., Minneapolis, Minn.

Marvin Olcott, Corning, N. Y.
C. R. Maltby & Bros.

Francis Stuyvesant Peabody, 107 Dearborn st., Chicago, Ill.

Oliver Phelps, Canandaigua, N. Y.

Addison Alexander Righter, Yantic, Conn.
Mechanical Engineer, Yantic Woolen Mills.

George Lewis Sargent, LL.B., New Haven, Conn.
Sargent & Co., Manufacturers of Hardware.

Louis Jacob Schiller, 7 Sargent's Wharf, Boston, Mass.
Chemist, Bay State Sugar Refinery.

Bernard Joseph Shanley, LL.B., 211 Franklin st., New Haven, Conn.

Frank Augustus Smith, 31 Lyon st., New Haven, Conn.

John Hayward Trumbull, M.D., Talcahuano, Chili.

Richard Lindsay Trumbull, LL.B., Talcahuano, Chili.

Howard Van Rensselaer, M.D., 98 Columbia st., Albany, N. Y.
46 E. 26th st., New York City.

Frank Charles Warner, West Suffield, Conn
Civil Engineer.

Robert William Watson, Indianapolis, Ind.
Civil Engineer, C. C. C. & I. R. R., Ashtabula, Ohio.

William Meeker Wood, Morristown, N. J.
Division Engineer, C. C. C. & I. R. R., Cleveland, Ohio.

Arthur Burnham Woodford, West Winsted, Conn.
Professor of Economic Science, Indiana University.

Clark Wright, M.D., 19 W. 36th st., New York City.

Willis Benton Wright, Duncan Building, Pine st., New York City.

Jeme Tien Yow, Foochow, China.
H. J. M. S. "Young Woo," Pagoda Anchorage.

1882.

Horace Ellsworth Andrews, Euclid and Sterling aves., Cleveland, Ohio.

Alfred Warner Armstrong, 879 Euclid ave., Cleveland, Ohio.

Charles Noyes Batcheller, Wallingford, Vt.
Batcheller & Sons, Manufacturing of Agricultural Implements.

Henry Jonathan Biddle, 1623 Walnut st., Philadelphia, Pa.

Francis Hayes Blake, Care Prof. W. P. Blake, New Haven, Conn.
Metallurgist and Foreman of Quartz Mill, Pinal, Arizona.

Nathan Gross Bozeman, M.D., 296 5th ave., New York City.

Frederick Casper, Meriden, Conn.
Meriden Silver Plate Co.

William Anson Chamberlin, 145 College st., New Haven, Conn.

William Henry Crocker, 322 Pine st., San Francisco, Cal.
Banker, Crocker, Woolworth & Co.

James John Drummond, Winfield, DuPage Co., Ill.
Civil Engineer.

†Richard Lawrence Everit, South Framingham, Mass.

Herbert Waldron Faulkner, D.E., Stamford, Conn.

William Alanson Hall, Greenville, Montcalm Co., Mich.

Alfred Edwards Hooker, A.B., M.D., 162 Prospect st., New Haven, Conn.

Alexander Bryan Johnson, M.D., 29 W. 17th st., New York City.
College of Physicians and Surgeons, New York.

Frederick William LaForge, Waterbury, Conn.

Samuel Waldron Lambert, A.B., M.D., 2 E. 37th st., New York City.

Frank Judson Lambert, 12 Eld st., New Haven, Conn.
Thos. Alling & Co.

Norman Smith Latham, C.E., North Manchester, Conn.
Assistant Engineer, South Penna. R. R.

Cassius Samuel Lyman, Box 65, Holyoke, Mass.
Principal of Thompsonville High School, Thompsonville, Conn.

Sheldon Elton Minor, Thomaston, Conn.
Civil Engineer.

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Louis Valentine Pirsson, New Haven, Conn.
Instructor in Analytical Chemistry, Sheffield Scientific School of Yale College.

Harry Smith Pope, 161 Summit ave., Jersey City, N. J.
Thos. J. Pope & Bros., New York City.

Robert Browning Rood, Jacksonville, Fla.
Manager Telephone Exchange.

Charles Edward Stockder, West Meriden, Conn.
Chas. Parker & Co.

Frederic Moore Strong, 420 N. State st., Chicago, Ill.
Armour & Co., 159 Washington st., Chicago, Ill.

Henry Taber, 22 E. 67th st., New York.
Johns Hopkins University, Baltimore, Md.

Arthur Graham Thompson, Milford, Conn.
H. G. Thompson & Sons, 51 Leonard st., New York City.

Edwin Thorne, 8 E. 55th st., New York City.

Thomas Pearsall Thorne, Thorndale, Millbrook, Dutchess Co., N. Y.

Walter Joy Vought, M.D., 29 W. 17th st., New York City.
48 Linwood ave., Buffalo, N. Y.

Edward Loder Whittemore, Bridgeport, Conn.
Bridgeport Malleable Iron Co.

Alfred Buckingham Willcox, 512 Washington st., Chicago, Ill.
Draughtsman, Link Belt Machinery Co.

Chauncey Pratt Williams, Jr., 284 State st., Albany, N. Y.
National Exchange Bank, Albany, N. Y.

Samuel Lawrence Williams, 400 Ontario st., Chicago, Ill.
Real Estate, Portland Block.

1883.

Paul Whitin Abbott, Whitinsville, Mass.
Wm. Stearnes & Co., 60 Chatham st., Boston, Mass.

John Alpheus Allen, Care of Prof. O. D. Allen, New Haven, Conn.
Chemist.

Benjamin Safford Barrows, M.D., 47 Clark st., Hartford, Conn.

George Andrew Barrows, LL.B., 300 N. 10th st., Philadelphia, Pa.

John Bartholomew, C.E., Guilford, Conn.
Chief Engineer, Hudson Bridge Works, Hudson, N. Y.

Frederic Robinson Bartlett, Freeport, Ill.
Manufacturer of Hardware.

Frederick Elijah Beach, 44 Lyon st., New Haven, Conn.
Peck Bros. & Co.

Frederick Truman Bradley, 406 State st., New Haven, Conn.
R. B. Bradley & Co., Agricultural and Wooden Ware.

Charles Sumner Brown, East Hampton, Conn.
Halle Gold Mining Co., South Carolina.

Charles Milo Carpenter, 29 S. 10th st., Minneapolis, Minn.
Minnesota Transfer Packing Co.

Horace Raymond Carpenter, Afton, N. Y.
Stock Raising, Fullerton, Nance Co., Neb.

Samuel Myron Chase, 554 Chapel st., New Haven, Conn.

Harry Nelson Covell, 7 Prospect st., Stamford, Conn.
Mechanical Engineer in Yale & Towne Manufacturing Co.

Wayne Darlington, West Chester, Pa.

Edward Bradford Dench, M.D., 74 South ave., Bridgeport, Conn.
116 Lexington ave., New York City.

Henry Kelsey Devereux. 1238 Euclid ave., Cleveland, O.
Civil Engineer, C. C. C. & I. R. R.

†Robert Ogden DuBois, M.D., 328 Howard ave., New Haven, Conn.

Edward Peers Eastwick, Jr., 125 E. 40th st., New York City.
Sugar Refining.

Horatio Southworth Frazer, Holyoke, Mass.

Charles Lockwood Gold, West Cornwall, Conn.
Farming.

Charles Stewart Hall, Youngstown, Ohio.
Civil Engineer, Morse Bridge Co.

George Vance Harper, Shippensburg, Cumberland Co., Pa.
Civil Engineer, American Construction Co., Harrisburg, Pa.

William Harper, New Bloomfield, Perry Co., Pa.
U. S. Bureau of Labor, Washington, D. C.

Allen Hubbard, Providence, R. I.
Mill Engineer, Riverside and Oswego Mills.

John Elmer Lockwood, Newburgh, N. Y.
Teacher.

William Ellison Lockwood, M.D., New Haven, Conn.
Assistant in Chemistry, Yale Medical School.

James Lyman, Middlefield, Conn.
Edison Electric Lighting Co., New York.

John Edmund Newell, 348 Ontario st., Chicago, Ill.
Superintendent Bessemer Department North Chicago Rolling Mill Co.

Henry Curtis Nutt, Jr., 87 Milk st., Boston, Mass.
Assistant Engineer, B. & M. R. R., Lincoln, Neb.

George Shipman Payson, 454 Dearborn ave., Chicago, Ill.

Edward Wells Penfield, 2456 Prairie ave., Chicago, Ill.
North Chicago Rolling Mill Co.

David Murdoch Pratt, 413 Lake st., Elmira, N. Y.
Banker, Second National Bank, Elmira, N. Y.

William Sherman Randall, M.D., Box 731, Birmingham, Conn.
116 Lexington ave., New York City.

Albert William Robert, 97 Water st., New York City.

Charles Lansing Sayre, 142 Park ave., Utica, N. Y.
Hardware.

Charles Locke Scudder, A.B., Great Barrington, Mass.

Horace Lee Simpson, M.D., Pensacola, Fla.
116 Lexington ave., New York City.

Ebenezer Hubbard Skinner, Escambia, Fla.
Manager Escambia Saw Mill.

Joseph Allen Skinner, Holyoke, Mass.
Silk Manufacturer.

Edward Irving Stone, Bethlehem, Conn.

John Edwards Stryker, LL.B., St. Paul, Minn.
14 E. 53d st., New York City.

Chuan Lok Wing.

†Alexander Wurts, New Haven, Conn.

Robert Hawthorne Wylie, M.D., 40 W. 40th st., New York City.

1884.

Gustavo Alfonso, 31 W. 47th st., New York City.
Sugar Merchant.

Edward Harvey Allcutt, 906 Penn st., Kansas City, Mo.
Plankington & Armour.

Lawrence Vincent Benét, 1717 I st., Washington, D. C.
Engineer with Hotchkiss & Cie, Manufacturers of Ordnance and Ammunition, 27 Rue Royale, Paris, France.

Edward Blake, 361 Temple st., New Haven, Conn.

Chauncey Rea Burr, 633 Congress st., Portland, Me.

Albert Park Campbell, 28 York sq., New Haven, Conn.
Draughtsman, Silsby Manufacturing Co., Seneca Falls, N. Y.

†Herbert DeWitt Carrington, 1169 Chapel st., New Haven, Conn.

William Brainard Coit, New London, Conn.

Clifford Laurence Colton, Collinsville, Conn.
Civil Engineer.

Louis Edward Cooper, Ansonia, Conn.

George Wyckoff Cummins, Vienna, N. J.

Percival Farquhar, 36 E. 23d st., New York City.
A. B. Farquhar & Co., Manufacturers of Agricultural Implements.

Arthur Bixby Ferguson, Care Rev. G. P. Torrence, Bethel, Conn.

Davenport Galbraith, Erie, Pa.

Morgan Augustus Guinnip, 404 Seventh st., Washington, D. C.
Guinnip & Co.

Calvin Linsley Harrison, 152 Wooster st., New Haven, Conn.

John Bell Hatcher, Cooper, Greene Co., Iowa.
U. S. Geological Survey, Long Island, Phillips Co., Kansas.

Samuel Brown Hawley, N. Broadway, Yonkers, N. Y.

Edwin Musser Herr, 448 Champa st., Denver, Col.
Draughtsman, C. M. & St. P. R. R.

Louis E. Hooper, Ansonia, Conn.

James Henry Jennings, Sheffield, Mass.
Assistant Topographer, U. S. Geological Survey.

Henry Clay Johnson, Rome, Ga.

Thomas Crossley Johnson, 80 Lafayette st., New Haven, Conn.

Edson Keith, 1906 Prairie ave., Chicago, Ill.

Duane Judson Kelsey, Killingworth, Conn.
74 Lafayette st., New Haven, Conn.

Albert Lucas, 141 N. 4th st., Philadelphia, Pa.

Luther James Martin, 361 Elm st., New Haven, Conn.

George Edgar Moulthrop, 253 N. Front st., New Haven, Conn.

William Wallace Nichols, Cliff House, Manitou Springs, Col.

Albert Anderson Noye, 291 North st., Buffalo, N. Y.
John F. Noye Manufacturing Co.

Herbert Lincoln Noyes, Box 487, Leadville, Col.
Fair Hopes Mining Co.

Joseph Powell, Towanda, Pa.
Civil Engineer.

Joseph Warren Rogers, Scarborough on the Hudson, N. Y.
Contracting Engineer, Edison Electric Lighting Co., Box 58, Harrisburg, Pa.

Walter Allen Sadd, Cheyenne, Wyoming Terr.
Assistant Engineer, Union Pacific R. R.

William Godfrey Sage, 5 E. 40th st., Chicago, Ill.
Pennsylvania R. R. Workshops, Altoona, Pa.

Russell Sargent, 51 Elm st., New Haven, Conn.

Clarence Wellington Sheldon, 123 Montague st., Brooklyn, N. Y.

William Tuttle Shepard, Bristol, Conn.
Assistant Engineer, City Engineer's Office, New Haven, Conn.

John Prentice Terry, Remsen st., Brooklyn, N. Y.

Chester Thorne, Millbrook, Dutchess Co., N. Y.
Assistant Engineer, Missouri Pacific R. R., 906 Penn st., Kansas City, Mo.

James Henry Warner, Portsmouth, O.

Elmore Abram Willets, Belmont, Alleghany Co., N. Y.
Oil Producer.

Andrew Lincoln Winton, New Haven, Conn.
Assistant Chemist, Connecticut Agricultural Experiment Station.

Franklin Eldred Worcester, A.B., 76 High st., New Haven, Conn.
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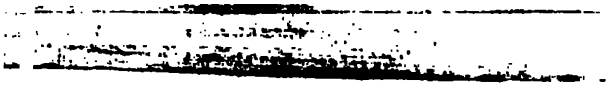

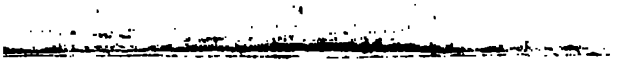

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